NOBLE DENTON

Noble Denton International Ltd
Marine and Engineering Consultants and Surveyors

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GENERAL GUIDELINES FOR MARINE TRANSPORTATIONS

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PREFACE

This document has been drawn with care to address what are likely to be the main concerns based on the experience of the Noble Denton organisation. This should not, however, be taken to mean that this document deals comprehensively with all of the concerns which will need to be addressed or even, where a particular matter is addressed, that this document sets out the definitive view of the organisation for all situations. In using this document, it should be treated as giving guidelines for sound and prudent practice on which our advice should be based, but these guidelines should be reviewed by the responsible person in each project to ensure that the particular circumstances of that project are addressed in a way which is adequate and appropriate to ensure that the overall advice given is sound and comprehensive.

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1 SUMMARY

1.1 CONTENT AND SCOPE

1.1.1 This document describes the guidelines which will be used by Noble Denton for approval of specialised marine transportations, including;

a. Cargoes on towed barges or ships

b. Towage of self-floating marine and oilfield equipment, civil engineering structures and ships.

1.1.2 This document is not intended to apply to "standard" cargoes such as bulk liquids, bulk solids, refrigerated cargoes, vehicles or containers.

1.1.3 This Revision 2 contains a new section covering towages in ice conditions.

1.1.4 It should be noted that this document cannot cover every case of all transportation types. The reader should satisfy himself that the guidelines used are fit for purpose for the actual transportation under consideration.

1.1.5 In general, in addition to compliance with these Guidelines, towing operations should comply with the mandatory parts of relevant IMO documents. The approval of any transportation by Noble Denton does not imply that approval by any other involved parties would be given. These Guidelines are intended to ensure the safety of the transported equipment. They do not specifically apply to the safety of personnel or protection of the environment, for which more stringent guidelines may be appropriate, in some cases.

1.1.6 These Guidelines are not intended to exclude alternative methods, new technology and new equipment, provided an equivalent level of safety can be demonstrated.

1.2 THE APPROVAL PROCESS

1.2.1 A description of the Approval Process is included, for projects where Noble Denton is acting as a Warranty Surveyor. The extent and limitations of the approval given are discussed.

1.3 DOCUMENTATION

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1.4 METEOROLOGICAL CONDITIONS, VESSEL MOTIONS AND LOADINGS, AND SEAFASTENING DESIGN

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1.4.2 Alternative means of computing vessel motions are given, as are default motion criteria.

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1.4.4 Considerations are given for the design of grillage and seafastenings, and assessing the strength of the cargo.

1.5 STABILITY

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1.7 PLANNING AND CONDUCT OF THE TOWAGE OR VOYAGE

1.7.1 The planning and conduct of the towage or voyage is discussed.

1.8 MULTIPLE TOWAGES

1.8.1 The different types of multiple towages are defined, and the practical problems and acceptability of each are discussed.

1.9 SPECIAL CONSIDERATIONS

Special considerations are given for;

a. Transport or towage of jack-ups

b. Towage of ships, including demolition towages

c. Towage of FPSOs and similar vessels

d. Towages of vessels and structures in ice covered waters.

2 INTRODUCTION

2.1 This document describes the guidelines for approval of specialised marine transportations, including;

a. Transportation of cargoes on towed barges

b. Transportation of specialised cargoes on ships

c. Transportation of specialised cargoes on submersible, heavy lift vessels

d. Towage of ships including demolition towages

e. Towages of self-floating marine and oilfield equipment such as mobile offshore drilling units (MODUs), self floating jackets, floating docks, dredgers, crane vessels and Floating Production Storage and Offload vessels (FPSOs)

f. One-off towages of self-floating civil engineering structures such as caissons, power plants, bridge components and submerged tube tunnel sections.

2.2 Where ND is acting as a consultant rather than a Warranty Surveyor, these Guidelines may also be applied, as a guide to good practice.

2.3 These Guidelines are not intended to be applicable to "standard" cargoes such as bulk liquids, bulk solids, refrigerated cargoes, vehicles or containers.

2.4 The document refers to other Noble Denton guidelines as appropriate.

2.5 This document supersedes and replaces earlier Noble Denton guidelines;

a. Guidelines for the transportation of specialised cargoes on ships and heavy transport vessels - 0007/NDI

b. Self-elevating platforms - guidelines for operations and towages (towage section only) - 0009/NDI (Ref. 1)

c. Guidelines for marine transportations - 0014/NDI

d. Guidelines for the towage of ships - 0026/NDI.

2.6 Revision 2 of this document supersedes Revision 1, and includes an additional Section 22, relating to towages in ice covered waters.

2.7 It should be noted that this document cannot cover every case of all transportation types. The reader should satisfy himself that the guidelines used are fit for purpose for the actual transportation under consideration.

2.8 Further information referring to other phases of marine operations may be found in;

a. Self-elevating platforms – guidelines for operations (operations section only) - 0009/NDI (Ref. 1)

b. Guidelines for loadouts - 0013/NDI (Ref. 2)

c. Concrete offshore gravity structures – General guidelines for approval of construction, towage and installation - 0015/NDI (Ref. 3)

d. Seabed and sub-seabed data required for approvals of mobile offshore units (MOU) - 0016/NDI (Ref. 4)

e. Guidelines for the approvability of towing vessels - 0021/NDI (Ref. 5)

f. Guidelines for lifting operations by floating crane vessels - 0027/NDI (Ref. 6)

g. Guidelines for the transportation and installation of steel jackets 0028/NDI - (Ref. 7).

2.9 All current Noble Denton Guideline documents can be downloaded from www.nobledenton.com.

2.10 The approval of any transportation by Noble Denton does not imply that approval by designers, regulatory bodies, harbour authorities and/or any other involved parties would be given, nor does it imply approval of the seaworthiness of the vessel.

2.11 These Guidelines are intended to ensure the safety of the transported equipment. They do not specifically apply to the safety of personnel or protection of the environment, which are covered by other International and National Regulations. In some cases more stringent guidelines may be appropriate in order to protect personnel and the environment.

2.12 These Guidelines refer both to towages of barges and other self-floating equipment, and to voyages of self-propelled vessels. Where applicable, and unless particular distinction is required, the term "vessel" may include "barge", and "voyage" may include "towage", and vice versa.

2.13 The "Special Considerations" Sections 19 through 22 may amend, add to or contradict the general sections. Care should be taken to ensure that the special requirements are considered as appropriate.

2.14 These Guidelines are not intended to exclude alternative methods, new technology and new equipment, provided an equivalent level of safety can be demonstrated.

3 DEFINITIONS

3.1 Referenced definitions are underlined.

Term	Definition
ABS	American Bureau of Shipping
AISC	American Institute of Steel Construction
API	American Petroleum Institute
ASPPR	Arctic Shipping Pollution Prevention Regulations
Assured	The Assured is the person who has been insured by some insurance company, or underwriter, against losses or perils mentioned in the policy of insurance.
Barge	A non-propelled vessel commonly used to carry cargo or equipment.
Benign area	An area that is free from tropical revolving storms and travelling depressions, (but excluding the North Indian Ocean during the Southwest monsoon season, and the South China Sea during the Northeast monsoon season). The specific extent and seasonal limitations of a benign area should be agreed with the Noble Denton office concerned.
Bollard pull	Bollard pull (BP) = Certified continuous static bollard pull of a tug measured in tonnes.
Breaking load	Breaking load (BL) = Certified minimum breaking load of wire rope, chain or shackles, tonnes.
BV	Bureau Veritas
Cargo	Where the item to be transported is carried on a barge or a vessel, it is referred to throughout this report as the cargo. If the item is towed on its own buoyancy, it is referred to as the tow.
Cargo ship safety certificates (Safety Construction) (Safety Equipment) (Safety Radio)	Certificates issued by a certifying authority to attest that the vessel complies with the cargo ship construction and survey regulations, has radiotelephone equipment compliant with requirements and carries safety equipment that complies with the rules applicable to that vessel type. Certificate validities vary and are subject to regular survey to ensure compliance.
CASPRR	Canadian Arctic Shipping Pollution Prevention Regulations
Certificate of Approval	A formal document issued by Noble Denton stating that, in its judgement and opinion, all reasonable checks, preparations and precautions have been taken to keep risks within acceptable limits, and an operation may proceed.

Term	Definition
Class	A system of ensuring ships are built and maintained in accordance with the Rules of a particular Classification Society. Although not an absolute legal requirement the advantages (especially as regards insurance) mean that almost all vessels are maintained in Class.
Cribbing	An arrangement of timber baulks, secured to the deck of a barge or vessel, formally designed to support the cargo, generally picking up the strong points in vessel and/or cargo.
Demolition towage	Towage of a "dead" vessel for scrapping.
Deratisation	Introduced to prevent the spread of rodent borne disease, Certification attesting the vessel is free of rodents (Derat Exemption Certificate) or has been satisfactorily fumigated to derat the vessel (Derat Certificate). Certificates are valid for 6 months unless further evidence of infestation found.
Design environmental condition	The design wave height, design wind speed, and other relevant environmental conditions specified for the design of a particular transportation or operation.
Design wave height	Typically the 10-year monthly extreme significant wave height, for the area and season of the particular transportation or operation.
Design wind speed	Typically the 10-year monthly extreme 1-minute wind velocity at a reference height of 10 m above sea level, for the area and season of the particular transportation or operation.
DNV	Det Norske Veritas
Double tow	The operation of towing two tows with two tow wires by a single tug.
Dry Towage (or Dry Tow)	Transportation of a cargo on a barge towed by a tug. Commonly mis-used term for what is actually a voyage with a powered vessel, more properly referred to as 'Dry Transportation'
Dry Transportation	Transportation of a cargo on a barge or a powered vessel.
Dunnage	An arrangement of timber on the deck of a barge or vessel, laid out to support the cargo. See also cribbing.
EPIRB	Emergency Position Indicating Radio Beacon

Term	Definition
Field move	Any move of a MODU or similar within or in the vicinity of an oil or gas-field or other area of operations, which can be completed within the time for which a reliable good weather forecast may reasonably be expected, having due regard to area and season. Jacking or other operations at the start and finish of the move shall be taken into account. See also location move and weather-restricted operation.
Floating offload	The reverse of floating onload
Floating onload	The operation of transferring a cargo, which itself is floating, onto a vessel or barge, which is submerged for the purpose.
FPSO	Floating Production, Storage and Offload vessel
GL	Germanische Lloyd
GMDSS	Global Maritime Distress and Safety System
GPS	Global Positioning System
Grillage	A steel structure secured to the deck of a barge or vessel, formally designed to support the cargo and distribute the loads between the cargo and barge or vessel.
IMO	International Maritime Organisation
Independent leg jack-up	A jack-up where the legs may be raised or lowered independently of each other.
Insurance Warranty	A clause in the insurance policy for a particular venture, requiring the approval of a marine operation by a specified independent survey house.
IOPP Certificate	International Oil Pollution Prevention Certificate (see also MARPOL)
ISM Code	International Safety Management Code - the International Management Code for the Safe Operation of Ships and for Pollution Prevention - SOLAS Chapter IX (Ref. 8)
Jack-up	A self-elevating MODU, MOU or similar, equipped with legs and jacking systems capable of lifting the hull clear of the water.
Line pipe	Coated or uncoated steel pipe sections, intended to be assembled into a Pipeline
Load line	The maximum depth to which a ship may be loaded in the prevailing circumstances in respect to zones, areas and seasonal periods. A Loadline Certificate is subject to regular surveys, and remains valid for 5 years unless significant structural changes are made.
Loadout	Transferring a cargo onto a vessel or barge, from the shore or from another vessel or barge.

Term	Definition
Location move	A move of a MODU or similar, which, although not falling within the definition of a field move, may be expected to be completed with the unit essentially in field move configuration, without overstressing or otherwise endangering the unit, having due regard to the length of the move, and to the area (including availability of shelter points) and season.
LRFD	Load and Resistance Factor Design
LRS	Lloyds Register of Shipping
Marine operation	See Operation
MARPOL	International Convention for the Prevention of Pollution from Ships 1973/78, as amended.
Mat-supported jack-up	A jack-up which is supported in the operating mode on a mat structure, into which the legs are connected and which therefore may not be raised or lowered independently of each other.
MODU	See MOU
MOU	Mobile Offshore Unit. For the purposes of this document, the term may include mobile offshore drilling units (MODUs), and non-drilling mobile units such as accommodation, construction, lifting or production units
Multiple tow	The operation of towing more than one tow by a single tug.
Noble Denton	Any company within the Noble Denton Group including any associated company which carries out the scope of work and issues a Certificate of Approval, or provides advice, recommendations or designs as a consultancy service.
Ocean towage	Any towage which does not fall within the definition of a restricted operation, or any towage of a MODU or similar which does not fall within the definition of a field move or location move.
Ocean transportation	Any transportation which does not fall within the definition of a restricted operation
Off-hire survey	A survey carried out at the time a vessel, barge, tug or other equipment is taken off-hire, to establish the condition, damages, equipment status and quantities of consumables, intended to be compared with the on-hire survey as a basis for establishing costs and liabilities.
Offload	The reverse of loadout

Term	Definition
On-hire survey	A survey carried out at the time a vessel, barge, tug or other equipment is taken on-hire, to establish the condition, any pre-existing damages, equipment status and quantities of consumables, intended to be compared with the off-hire survey as a basis for establishing costs and liabilities. It is not intended to confirm the suitability of the equipment to perform a particular operation.
Operation, marine *operation*	Any activity, including loadout, transportation, offload or installation, which is subject to the potential hazards of weather, tides, marine equipment and the marine environment,
Operational reference period	The planned duration of an operation including a contingency period.
Parallel tow	The operation of towing two tows with one tow wire by a single tug, the second tow being connected to a point on the tow wire ahead of the first tow with the catenary of its tow wire passing beneath the first tow.
Pipe carrier	A vessel specifically designed or fitted out to carry Line pipe
Port of refuge	A location where a towage or a voyage seeks refuge, as decided by the Master, due to events occurring which prevent the towage or voyage proceeding towards the planned destination. A safe haven where a towage or voyage may seek shelter for survey and/or repairs, when damage is known or suspected.
Port (or point) of shelter	See Shelter point
Procedure	A documented method statement for carrying out an operation
Registry	Registry indicates who may be entitled to the privileges of the national flag, gives evidence of title of ownership of the ship as property and is required by the need of countries to be able to enforce their laws and exercise jurisdiction over their ships. The Certificate of Registry remains valid indefinitely unless name, flag or ownership changes.
Restricted operation	See Weather-restricted operation.
Risk assessment	A method of hazard identification where all factors relating to a particular operation are considered.
Safety Management Certificate (SMC)	A document issued to a ship which signifies that the Company and its shipboard management operate in accordance with the approved SMS.
Safety Management System (SMS)	A structured and documented system enabling Company personnel to implement the Company safety environmental protection policy.

Term	Definition
SART	Search and Rescue Radar Transponder
Seafastening	The means of preventing movement of the cargo or other items carried on or within the barge, vessel, or tow.
Semi-submersible	A MODU or similar designed to operate afloat, generally floating on columns which reduce the water-plane area, and usually moored to the seabed when operating.
Shelter point (or shelter port, or point of shelter)	An area or safe haven where a towage or vessel may seek shelter, in the event of actual or forecast weather outside the design limits for the transportation concerned. A planned holding point for a staged transportation.
Single tow	The operation of towing a single tow with a single tug.
SOPEP	Shipboard Oil Pollution Emergency Plan
Staged transportation	A transportation which can proceed in stages between shelter points, not leaving or passing each shelter point unless there is a suitable weather forecast for the next stage. Each stage may, subject to certain safeguards, be considered a weather-restricted operation.
Submersible transport vessel	A vessel which is designed to ballast down to submerge its main deck, to allow self-floating cargoes to be on-loaded and off-loaded.
Suitability survey	A survey intended to assess the suitability of a tug, barge, vessel or other equipment to perform its intended purpose. Different and distinct from an on-hire survey.
Survey	Inspection of commodity, structure or item for the purposes of determining condition, quantity, quality or suitability.
Tandem tow	The operation of towing two or more tows in series with one tow wire from a single tug, the second and subsequent tows being connected to the stern of the tow ahead.
Tonnage	A measurement of a vessel in terms of the displacement of the volume of water in which it floats, or alternatively, a measurement of the volume of the cargo carrying spaces on the vessel. Tonnage measurements are principally used for freight and other revenue based calculations. Tonnage Certificates remain valid indefinitely unless significant structural changes are made
Tow	The item being towed. This may be a barge or vessel (laden or un-laden) or an item floating on its own buoyancy. Approval by Noble Denton of the tow will normally include, as applicable, consideration of condition and classification of the barge or vessel; strength; securing and weather protection of the cargo; draft; stability; documentation; emergency equipment; lights, shapes and signals; fuel and other consumable supplies; manning.

Term	Definition
Towage	The operation of transporting a non-propelled barge or vessel (whether laden or not with cargo) or other floating object by towing it with a tug.
Towing (or towage) arrangements	The procedures for effecting the towage. Approval by Noble Denton of the towing (or towage) arrangements will normally include consideration of towlines and towline connections; weather forecasting; pilotage; routeing arrangements; points of shelter; bunkering arrangements; assisting tugs; communication procedures.
Towing vessel	See tug
Towing Vessel Approvability Certificate (TVAC)	A document issued by Noble Denton stating that a towing vessel complied with the requirements of Ref 5 at the time of survey, or was reportedly unchanged at the time of revalidation, in terms of design, construction, equipment and condition, and is considered suitable for use in towing service within the limitations of its Category, bollard pull and any geographical limitations which may be imposed.
Towing Vessel Approvability Scheme (TVAS)	The scheme whereby owners of towing vessels may apply to have their vessels surveyed, leading to the issue of a TVAC.
Towing vessel	See Tug
Towline connection strength	Towline connection strength (TC) = ultimate load capacity of towline connections, including connections to barge, bridle and bridle apex, in tonnes.
Towline pull required (TPR)	The towline pull computed to hold the tow, or make a certain speed against a defined weather condition, in tonnes.
Transportation	The operation of transporting a tow or a cargo by a towage or a voyage.
Tug	The vessel performing a towage. Approval by Noble Denton of the tug will normally include consideration of the general design; classification; condition; towing equipment; bunkers and other consumable supplies; emergency and salvage equipment; communication equipment; manning.
Tug efficiency (Te)	Defined as; $\frac{\text{Effective bollard pull produced in the weather considered}}{\text{Certified continuous static bollard pull}}$
TVAS	Towing Vessel Approvability Scheme

Term	Definition
Ultimate load capacity	Ultimate load capacity of a wire rope, chain or shackle or similar is the certified minimum breaking load, in tonnes. The load factors allow for good quality splices in wire rope. Ultimate load capacity of a padeye, clench plate, delta plate or similar structure, is defined as the load, in tonnes, which will cause general failure of the structure or its connection into the barge or other structure.
Vessel	A marine craft designed for the purpose of transportation by sea.
Voyage	For the purposes of this report, the operation of transporting a cargo on a powered vessel from one location to another.
Watertight	A watertight opening is an opening fitted with a closure designated by Class as watertight, and maintained as such, or is fully blanked off so that no leakage can occur when fully submerged.
Weather-restricted operation	An operation with an operational reference period generally less than 72 hours. The design environmental condition for such an operation may be set independent of extreme statistical data, subject to certain precautions.
Weathertight	A weathertight opening is an opening closed so that it is able to resist any significant leakage from one direction only, when temporarily immersed in green water or fully submerged.
Weather un-restricted operation	An operation with an operational reference period generally greater than 72 hours. The design environmental condition for such an operation shall be set in accordance with extreme statistical data.
WMO	World Meteorological Organisation
WSD	Working Stress Design

4 THE APPROVAL PROCESS

4.1 GENERAL

4.1.1 Noble Denton may act as a Warranty Surveyor, giving Approval to a particular operation, or as a Consultant, providing advice, recommendations, calculations and/or designs as part of the Scope of Work. These functions are not necessarily mutually exclusive.

4.2 NOBLE DENTON APPROVAL

4.2.1 By Noble Denton is meant any company within the Noble Denton Group including any associated company which carries out the scope of work and issues a Certificate of Approval.

4.2.2 Noble Denton approval may be sought where the towage, voyage or operation is the subject of an Insurance Warranty, or where an independent third party review is required.

4.2.3 An Insurance Warranty is a clause in the insurance policy for a particular venture, requiring the approval of a marine operation by a specified independent survey house. The requirement is normally satisfied by the issue of a Certificate of Approval. Responsibility for interpreting the terms of the Warranty so that an appropriate Scope of Work can be defined rests with the Assured.

4.2.4 Noble Denton approval may be required for the loadout and offload operations, either in addition to the transportation, or where such operations are deemed to be part of the transportation.

4.3 CERTIFICATE OF APPROVAL

4.3.1 The deliverable of the approval process will generally be a Certificate of Approval.

4.3.2 The Certificate of Approval is the formal document issued by Noble Denton when, in its judgement and opinion, all reasonable checks, preparations and precautions have been taken to keep risks within acceptable limits, and an operation may proceed.

4.3.3 A certificate confirming adequate preparation for a transportation will normally be issued by the attending surveyor immediately prior to departure, when all preparations including seafastening and ballasting are complete, the barge or vessel, cargo, tug and towing connections (as applicable) have been inspected, and the actual and forecast weather are suitable for departure.

4.4 SCOPE OF WORK LEADING TO AN APPROVAL

4.4.1 In order to issue a Certificate of Approval, Noble Denton will typically require to consider, as applicable, the following topics;

a. History, condition and documentation of the tow or cargo

b. Voyage or towage route, season and design environmental conditions, with shelter points if applicable

c. Capability of the vessel or barge to carry the cargo

d. Vessel, barge or tow motions

e. Strength of the tow, cargo, seafastening and cribbing to withstand static and motion induced transportation loads

f. Stability of the vessel, barge or tow

g. Towing resistance and required bollard pull

h. Towing vessel specification and documentation

i. Towing connections and arrangements

j. Weather protection of the tow or cargo

k. Seafastening of items and substructures within the tow or cargo

l. Arrangements for receiving weather forecasts along the route

m. Transportation procedures, including arrangements for holding or deviating to shelter points if required.

4.4.2 If approval is also required for the onload and/or offload operations of a self-floating cargo onto/from a submersible vessel or barge, then the following will typically require consideration;

a. Location details, water depth, tidal conditions and meteorological exposure.

b. Vessel or barge moorings.

c. Stability and ballasting conditions during the load transfer operation and the critical parts of the deballasting/ballasting operation.

d. Cribbing position and securing during submergence.

e. Towing and handling arrangements for the cargo.

f. Cargo positioning arrangements.

g. Reactions between vessel or barge and cargo.

h. Limiting weather conditions for the operation.

4.4.3 If approval is required for loadout from the shore onto a vessel or barge, offload from a vessel or barge to the shore, or lifting from a vessel or barge to a platform, reference should be made to documents 0013/NDI (Ref. 2) and 0027/NDI (Ref. 6) as appropriate.

4.4.4 Technical studies leading up to the issue of a Certificate of Approval for transportation may consist of;

a. Reviews of specifications, procedures and calculations submitted by the client or his contractors, or

b. Independent analyses carried out by Noble Denton to verify the feasibility of the proposals, or

c. A combination of third party reviews and independent analyses.

4.4.5 Surveys required in order to issue a Certificate of Approval will typically include;

a. Survey of the transport vessel or barge

b. Survey of the tow or cargo

c. Survey of completed seafastenings and other voyage preparations including vessel or barge readiness, ballast condition, cargo securing, weather-tightness and internal seafastening

d. Survey of tug and towing connections, if applicable

e. Inspection of documentation for vessel, barge and tug as appropriate

f. Review of actual and forecast weather for departure

4.4.6 The above surveys may be carried out immediately before departure, but the client may consider it in his interests to have initial surveys carried out in advance, to reduce the risk of rejection of any major item.

4.4.7 Tugs in possession of a Noble Denton Towing Vessel Approvability Certificate (TVAC) may be pre-approved in principle in advance. It may be advisable to request a survey of an unknown tug prior to mobilisation.

4.4.8 Whilst not forming part of the surveys required for approval, the client may also consider it in his interests to have on- and off-hire surveys performed of equipment taken on charter, in order to establish inventories of equipment and consumables, and liability for degradation or damage.

4.5 LIMITATION OF APPROVAL

4.5.1 A Certificate of Approval is issued for a specific towage, voyage or operation only.

4.5.2 A Certificate of Approval is issued based on external conditions observed by the attending surveyor of hull, machinery and equipment, without removal, exposure or testing of parts.

4.5.3 A Certificate of Approval shall not be deemed or considered to be a general Certificate of Seaworthiness.

4.5.4 A Certificate of Approval for a towage or voyage does not include any moorings prior to the start of the towage or voyage, or at any intermediate shelter, bunkering or arrival port, unless specifically approved by Noble Denton.

4.5.5 No responsibility is accepted by Noble Denton for the way in which the towage or voyage is conducted, this being solely the responsibility of the master of the tug or vessel.

4.5.6 The towage is deemed to be completed and the related Certificate of Approval invalidated when the approved tug(s) is/are disconnected.

4.5.7 Fatigue damage is excluded from any Noble Denton approval, unless specific instructions are received from the client to include it in the scope of work.

4.5.8 Any alterations in the surveyed items or agreed procedures or arrangements, after issue of a Certificate of Approval, may render the Certificate void unless the alterations are specifically approved by Noble Denton.

4.5.9 The Certificate covers the surveyed items within the agreed scope of work only. It does not, for instance, cover any other cargo on board a vessel or barge, or any damage to the surveyed cargo as a consequence of inadequacy of any other cargo or its seafastenings, unless specifically included in the scope of work.

5 CERTIFICATION AND DOCUMENTATION

5.1 GENERAL

5.1.1 In general, some or all of the documentation listed in the Table in Section 5.3 will be required. Some documentation is mandatory to comply with international legislation and standards. The documentation and certification requirements for any particular structure, vessel or operation should be determined in advance. Where new documentation is needed, the issuing authority and the Rules to be applied should be identified.

5.2 DOCUMENTATION DESCRIPTION

5.2.1 Principal documentation and certification is described in the following Table;

Document/Certificate	Description
Cargo Ship Safety Construction	Covers the hull, machinery and equipment of a cargo ship, and shows that the ship complies with the construction and safety regulations applicable to the ship and the voyages she is to be engaged in. Issued by the Flag State, or appointed Classification Society.
Cargo Ship Safety Equipment	This is a record of the safety equipment carried on the vessel, in compliance with SOLAS, including life saving appliances, fire fighting equipment, lights and shapes, pilot ladders, magnetic compass etc. Issued by the Flag State, or appointed Classification Society.
Class (Hull and machinery)	Vessels and their machinery, built and maintained in accordance with the Rules of a Classification Society will be assigned a class in the Society's Register Book, and issued with the relevant Certificates, which will indicate the character assigned to the vessel and machinery. Issued by the Classification Society.
Customs clearance	Issued by Customs confirming that so far as they are concerned the vessel is free to sail. Issued after light dues have been paid, and on production of various other mandatory documentation.
De-rat, or De-rat Exemption	A De-rat Certificate is issued after a vessel has been fumigated, or dealt with be other means to rid her of rats. A De-rat exemption is issued where inspection has shown no evidence of rats on board. Issued by a Port medical officer.
Garbage Management Plan	A Class-approved document for management of waste.
International Oil Pollution Prevention	Certifies that the vessel complies with international oil pollution regulations (MARPOL Annex 1). Unless stated otherwise, all vessels over 400 grt must comply with the requirements of the code. Issued by the Flag State, or appointed Classification Society.

Document/Certificate	Description
Lifesaving Appliances	Normally covered under Cargo Ship Safety Equipment Certificate. Where temporary equipment, e.g. liferafts or fire fighting equipment, is placed on a structure not in possession of a Cargo Ship Safety Equipment Certificate, it is expected that each would be individually certified, with an in-date inspection.
Load Line	Issued after a vessel has been marked with her assigned load line marks. The Certificate gives details of the dimensions related to the freeboard, and the various special marks, e.g. TF (Tropical Fresh), WNA (Winter North Atlantic) etc. The vessel must be periodically inspected, to confirm that no changes have occurred to the hull or superstructure which would render invalid the data on which the assignment of freeboard was made. Issued by the Flag State, or appointed Classification Society.
Load Line Exemption	Where a vessel or structure is exempt from some or all of the provisions of the above, it may be issued with a Load Line Exemption Certificate, which will include any qualifying provisions. Issued by the Flag State, appointed Classification Society, or Port Authority.
Navigation Lights and Shapes	Normally covered under Cargo Ship Safety Equipment Certificate. Where temporary lights are placed on a structure not in possession of a Cargo Ship Safety Equipment Certificate, it is expected that they would be individually certified, or in possession of a manufacturer's guarantee of compliance.
Panama Canal documentation	For transit through the Panama Canal, drawings are required showing the extent of visibility from the bridge, and the extension of bilge keels, if fitted.
Registry	The Certificate of Registry is required by all commercial vessels. It contains the details from the Flag State Register in which the vessel has been registered, including principal dimensions, tonnage, and ownership. Issued by the Flag State Register.
Safe Manning document	A document issued by Flag State, showing the minimum safe manning for a vessel
Safety Management Certificate (SMC) - Document of Compliance	A document issued to a ship which signifies that the Company and its shipboard management operate in accordance with the approved Safety Management System. Issued by the Flag State, or appointed Classification Society.

Document/Certificate	Description
Safety Radio	Issued by the Flag State after survey of the vessel's radio installation, declaring that it is satisfactory for the intended service.
SOPEP	Shipboard Oil Pollution Emergency Plan - Class approved
Stability booklet	A booklet setting out the vessel's stability particulars, and allowing the actual draft, trim and stability characteristics to be determined for any cargo arrangement. Usually prepared by designers, and must be approved by the Classification Society.
Tonnage	Shows the Tonnage as obtained by measurement, and is a measure of volume rather that weight. 1 ton equals 2.83 cu.m (100 cu.ft). Measured by a surveyor appointed by the Flag State.

5.3 ICE CLASS

5.3.1 See the comments relating to Ice Class vessels in Section 22.2.

5.4 REQUIRED DOCUMENTATION

5.4.1 In general the following documentation (shown as "✓") will be required or recommended for the transportation of various types of vessels and floating structures;

Document	Cargo vessels (Note 1)	Tugs (Note 1)	Barges (Note 2)	FPSO towages	Demolition towages	Other towages
Certificate of registry	✓	✓	✓	-	-	-
Certificate of class (hull)	✓	✓	✓	✓	-	-
Certificate of class (machinery)	✓	✓	✓	-	-	-
Tonnage certificate	✓	✓	✓	-	-	-
Cargo ship safety construction certificate	✓	✓	✓	-	-	-
Cargo ship safety equipment certificate	-	✓	✓	-	-	-
Certificates for navigation lights and shapes	-	-	-	✓	✓	✓
Load line certificate	✓	✓	✓	-	-	-
Load line exemption	-	-	-	✓	-	✓
IOPP Certificate	✓	✓	✓	✓	-	-
Safety Management Certificate (SMC)	✓	✓	-	-	-	-
Customs clearance	✓	✓	✓	✓	✓	✓
Deratisation certificate, or exemption	✓	✓	✓	✓	-	✓
Radio certificate, including GMDSS	✓	✓	-	-	-	-
Stability booklet	✓	✓	✓	✓	-	-
Bollard pull certificate	-	✓	-	-	-	-
Certificates for bridle, tow wires, pennants, stretchers and shackles	-	✓	✓	✓	✓	✓
Suez or Panama Canal documentation (if relevant)	✓	✓	✓	✓	✓	✓
Manned tows						
Load line or Load Line Exemption	-	-	✓	✓	✓	✓
Certificates for life saving appliances	-	-	✓	✓	✓	✓
Crew list	-	-	✓	✓	✓	✓
Radio Certificate	-	-	✓	✓	✓	✓

Notes;

1. Smaller vessels may be exempt from some Certification requirements.
2. Unmanned barges will not be required to have Safety Equipment Certificates. Derat Certificate or IOPP, unless fitted with machinery.
3. Some documentation is not required for inland voyages or inland towages.

6 DESIGN ENVIRONMENTAL CONDITIONS

6.1 INTRODUCTION

6.1.1 Each transportation shall be designed to withstand the loads caused by the most adverse environmental conditions expected for the area and season through which it will pass, taking account of any agreed mitigating measures.

6.1.2 For each phase of a transportation or marine operation, the design criteria should be defined, consisting of the design wave, design wind and, if relevant, design current. It should be noted that the maximum wave and maximum wind may not occur in the same geographical area, in which case it may be necessary to check the extremes in each area, to establish governing loadcases.

6.1.3 Except as allowed by Sections 6.3 and 6.5 below, the transportation should generally be designed to the 10-year monthly extremes for the area and season, on the basis of a 30 day exposure.

6.2 OPERATIONAL REFERENCE PERIOD

6.2.1 Planning and design of marine transportations shall be based on an operational reference period equal to the planned duration of the operation plus a contingency period.

6.2.2 The planned duration for a transportation shall include, typically;

a. The time anticipated, after the departure decision, preparing for departure or waiting for the correct tidal conditions.

b. The time anticipated for the voyage or towage itself

c. Time anticipated on arrival, waiting for the correct tidal conditions to enter harbour

d. If the operation following the transportation is a weather-dependent marine operation such as installation, the time required after arrival at the installation site to reach a safe condition.

6.2.3 The contingency period shall include, as appropriate;

a. An allowance for slower than predicted voyage or towing speed, because of adverse weather conditions or vessel performance below specification

b. If the operation following the transportation is a weather-dependent marine operation such as installation, and the contingency action is to return to shelter, the time required to reach and enter the planned shelter point, in worsening weather conditions.

6.3 WEATHER-RESTRICTED OPERATIONS

6.3.1 A transportation with a reference period generally less than 72 hours may be classed as a weather-restricted operation. The design environmental conditions for such an operation may be set independent of extreme statistical data, provided that;

a. The statistics indicate an adequate frequency and duration of the required weather windows

b. Dependable weather forecasts are available

c. *The start of the operation is governed by an acceptable weather forecast, covering* the reference period

d. *A risk assessment has been carried out*

e. Adequate marine procedures are in place.

6.3.2 A transportation with a reference period greater than 72 hours may exceptionally be classed as a weather-restricted operation, provided that;

a. An adequate shelter point is always available within 48 hours, at any point along the route, which can be entered in worsening weather, or the transport has sufficient speed to pass through or deviate round the area of forecast severe weather

b. An acceptable weather routing service is contracted and is available for advice at any time

c. Weather forecasts are received at appropriate intervals

d. The weather forecast service is contracted to issue a warning should the weather forecast deteriorate

e. Management resources of interested parties are always available with the right authority level to monitor any decision to proceed to shelter

f. A risk assessment has been carried out

g. *Adequate marine procedures and equipment are in place.*

6.3.3 For weather-restricted operations, the maximum forecast operational criteria should be lower than the design criteria by a margin depending on the area and season, the delicacy of the operation, and the typical reliability of the forecast. The factor is dependent on the duration of the operation and the level of the design criteria set. Typically a factor of 0.7 times the design maxima may be used to determine the maximum forecast operational criteria.

6.4 UNRESTRICTED OPERATIONS

6.4.1 Except as allowed in Section 6.3.2, transportations with an operational reference period greater than 72 hours shall be defined as un-restricted operations.

6.5 CALCULATION OF "ADJUSTED" DESIGN EXTREMES, UNRESTRICTED OPERATIONS

6.5.1 The risk of encounter of extreme conditions by a particular transport is dependent on the length of time that it spends in those route sectors where extreme conditions are possible. If the length of time is reduced, then the probability of encountering extreme conditions is similarly reduced.

6.5.2 It is generally accepted that for a prolonged ocean transport the wind and wave design criteria should be those with a probability of exceedence per voyage of 0.1 or less. For an ocean transport of 30 days (or more), through meteorologically and oceanographically consistent areas, this corresponds to the 10 year monthly extreme.

6.5.3 Many transports last less than 30 days, or are potentially exposed to the most severe conditions for less than 30 days. Consequently, for shorter exposures, the 10 year monthly extreme may be adjusted for reduced exposure. This value is equivalent to the 10 voyage extreme and is also referred to as the 10% risk level extreme. This must not be confused with the 10% exceedence value for the transport, as discussed in Section 6.9.

6.5.4 If the 10 year extremes are due to a tropical cyclone it may not be appropriate to design to adjusted extremes. This is likely to be the case for barge or MODU towages that are not able to respond effectively to weather routeing.

6.6 CALCULATION OF EXPOSURE

6.6.1 For the purpose of the calculation of "adjusted" extremes the exposure time to potentially extreme or near extreme conditions is calculated taking consideration of the points discussed below.

a. The initial 48 hours of the transportation, is assumed to be covered by a reliable departure weather forecast and is excluded

b. The speed of the transport is reduced by taking the monthly mean wave heights along the route into consideration as described in Section 6.7.2

c. The speed of the transport is adjusted to take into consideration the mean currents as described in Section 6.7.3

d. A contingency time of 25 percent of the time is added. This allowance is to account for severe adverse weather, for tug breakdowns or other operational difficulties

e. A minimum exposure time of 3 days is considered.

6.7 CALCULATION OF VOYAGE SPEED

6.7.1 Voyage duration is calculated based on a quoted calm weather speed. Reduction in transport speed due to the sea state likely to be encountered in each route sector is taken into account.

6.7.2 The effect of the mean sea state on the transport speed in each route sector is calculated assuming that the wave height in which the transport will come to a dead stop is b (metres). This is typically 5m for barge towages, and 8m for ships. The calm weather speed is multiplied by a factor, F, defined by;

$$F = 1 - \left(H_m / b \right)^2$$

where Hm is the monthly mean wave height in that route sector.

6.7.3 The effect of the mean current on the transport speed in each route sector is calculated by adding the current vector (resolved with respect to the transport heading). For the calculation of exposure to the extreme conditions only negative currents which act to delay the transport are taken into account.

6.8 CALCULATION OF EXTREMES

6.8.1 The probability of non-exceedence of a value of wind speed or significant wave height in a particular route sector is expressed as a cumulative frequency distribution (e.g. a weibull distribution).

6.8.2 The probability that during some 3 (or 1) hour period the transport will experience a significant wave height (or wind speed) less than some value x is given by $F_X(x)$.

6.8.3 If it takes M hours to pass through the route sector and making the assumption that consecutive wave height and wind speed events are independent then the probability of not exceeding the value x is given by $[F_X(x)]^N$ where N=M/T. Typically a value of T=1 hour is applied for winds and T=3 hours for waves, which are a more persistent form of energy

6.8.4 If it is reasonable to expect that extremes of wind speed or wave height could occur in more than one route sector then the probability of not exceeding the value x is given by the product

$$\prod_i F_{X_i}(x)^{N_i}$$

6.8.5 The probability of encountering an extreme value of wind speed or significant wave height, during a particular transport, that is reached or exceeded once on average for every 10 transports is 0.1. The value of x is varied until

$$1-\prod_i F_{X_i}(x)^{N_i} \text{ is equal to } 0.1$$

to give the 10 transport extreme for the voyage or towage.

6.8.6 This value is also referred to as the "adjusted" extreme for the transport, or as having a risk level of 10%. The method may be adjusted to give other risk levels (e.g. 1% or 5%).

6.9 COMPARISON WITH PERCENTAGE EXCEEDENCE

6.9.1 Given a series of values of wind speed or significant wave height, as may be observed during a complete transport, some value y will be exceeded at some times but not others and the percentage exceedence of value y is equal to;

$$\frac{100 \times (\textit{number of times y exceeded})}{\textit{total number of observations}}$$

6.9.2 If each observed value of wind speed or significant wave height is assumed to last for some duration (typically 1 hour for winds and 3 hours for waves) then for example, during a transport lasting 10 days there will be 240 wind events and 80 wave events. On the transport, if a wind speed greater than 30 knots is observed during 24 separate, hourly occasions then the percentage exceedence of 30 knots is 10%.

6.9.3 The 10% risk level (as defined in Section 6.5.3) for a transport along a specific route, departing on a specific date is expected to occur only once, on average, in every 10 transports. However a value with a 10% exceedence level for the same route and departure date is likely to occur on average for 10% of the time on every transport.

6.9.4 Thus a 10% exceedence value is far more likely to occur than a 10% risk level value, or an adjusted, 10 year extreme value.

6.10 CRITERIA FROM TRANSPORT SIMULATIONS

6.10.1 If continuous time series of winds and waves are available along the entire transport route, an alternative way to develop criteria with a specified risk of exceedence in a single transport is to perform tow simulations. A large number of simulations can be performed, with uniformly spaced (in time) departure times during the specified month of departure over the number of years in the database. For each simulated transport, the maximum wind speed and the maximum wave height experienced somewhere along the tow route are retained. Then the probability distribution of these transport-maxima can be used to determine the value with a specified risk of exceedence in a random transport. For example, the value exceeded once in every 20 transports, on average, can be determined by reading off the value of wave height from the distribution of transport-maximum wave heights at the 95th percentile level.

6.10.2 If fatigue during tow is an issue, the complete distributions of winds and waves experienced during the transports (not just the transport-maximum values) can be archived. This will give the fraction of time that various wind and wave conditions are experienced.

6.10.3 The transport simulation method can be made to be very realistic. In its simplest form, the speed is kept constant, and no provision for departure delays to avoid weather, variation of speed due to inclement weather or ocean currents, weather avoidance en route through forecasting/routing services, or the use of safe havens is allowed. If the transport simulator cannot accommodate all these features, a reasonably conservative estimate of criteria can be derived by using a conservative (slow) estimate of the average speed. Care should be taken when choosing the average speed estimate - a slow speed may not be conservative if it results in the vessel apparently arriving in a route sector late enough to miss severe weather, which might have been encountered if arrival had been earlier.

6.11 METOCEAN DATABASE BIAS

6.11.1 Regardless of whether the method described in Section 6.8 or the method described in Section 6.10 is used, it is important to know the accuracy of the metocean database being used. Specifically, if there is a known bias in the wind or wave statistics for any segment of a tow, it is essential to adjust the criteria accordingly.

6.12 DESIGN WAVE HEIGHT

6.12.1 The design wave height shall be the significant wave height (Hsig), where Hsig = $4\sqrt{m_0}$ where m_0 is the sea surface variance. In sea states with only a narrow band of wave frequencies, Hsig is approximately equal to $H_{1/3}$ (the mean height of the largest third of the zero up-crossing waves).

6.13 DESIGN WIND SPEED

6.13.1 The design wind speed shall be the 1 minute mean velocity at a reference height of 10m above sea level. The 1 hour wind may also be needed in the calculation process.

6.14 CALCULATION OF BOLLARD PULL REQUIREMENTS

6.14.1 The design extremes are not used for calculation of bollard pull requirements, which are covered in Section 12.2.

7 MOTION RESPONSE

7.1 GENERAL

7.1.1 Design motions may be derived by means of motion response analyses, from model tank testing, or by using the default equivalent motion values shown in Section 7.9.

7.2 SEASTATE

7.2.1 For the motion analyses, seastates shall include all relevant spectra up to and including the design wave height for the most severe areas of the proposed voyage route. A wave height smaller than the design wave height, at the natural period of roll and/or pitch of the tow, should also be checked if necessary. "Long-crested" seas will be considered unless there is a justifiable basis for using "short-crested" seas. Consideration should be given to the choice of spectrum.

7.2.2 The most probable maximum responses are to be based on a 3 hour exposure period.

7.3 PERIODS

7.3.1 For all seastates considered, the peak period (T_p) should be varied as;

$$\sqrt{(13.H_{sig})} < T_p < \sqrt{(30.H_{sig})}$$

where Hsig is in metres, T_p in seconds.

7.3.2 The relationship between the peak period T_p and the zero-up crossing period T_z is dependent on the spectrum. For a mean JONSWAP spectrum (γ=3.3) $T_p/T_z = 1.286$; for a Pierson-Moskowitz spectrum $T_p/T_z = 1.41$.

7.3.3 The relationship between the peak period Tp and the mean period Tm is given by $T_p/T_m = 1.296$.

7.3.4 Alternatively, if a detailed analysis of the joint probability distribution of significant wave height vs. peak wave period (T_p) is carried out, the following criteria may be applied;

a. Analyse the transport for the period of the design wave for $T_p \pm 1$ sec, and;

b. Analyse the transport for combinations of significant wave height and peak period having the same joint probability of occurrence as the design wave height and the most probable peak period. The effect of swell shall be considered .

7.4 VESSEL HEADING AND SPEED

7.4.1 The analyses should be carried out for zero vessel speed, and an appropriate forward speed if not zero, and for head, bow quartering, beam, stern quartering and stern seas.

7.5 THE EFFECTS OF FREE SURFACES

7.5.1 The application of free surface corrections to reduce metacentric height (GM) and hence to increase natural roll period will not generally be accepted. The effect of any reduction in GM must, however, be considered in intact and damage stability calculations.

7.6 THE EFFECTS OF CARGO IMMERSION

7.6.1 *The effect of cargo immersion in increasing GM and hence reducing natural roll* period as well as increasing damping should be considered in motion response analyses.

7.7 MOTION RESPONSE COMPUTER PROGRAMS

7.7.1 Computer programs shall be validated against a suitable range of model test results in irregular seas. The validation is to be made available to Noble Denton and is to contain appropriate analytical work which must be compared with applicable model tests.

7.7.2 When applying the results of a first-order motion response analysis program, heave shall be assumed to be parallel to the global vertical axis. Therefore the component of heave parallel to the deck at the computed roll or pitch angle (theta) is additive to the forces caused by the static gravity component and by the roll or pitch acceleration.

7.8 RESULTS OF MODEL TESTS

7.8.1 Model tests may be used to derive design motions, provided the tests pass the usual review of overall integrity. Generally, for transportation analyses, the model test results should present the standard deviation of the relevant responses. The standard deviation of the responses should then be multiplied by $\sqrt{(2.\log_n(N))}$, where N is the number of zero-upcrossings, to obtain the most probable maximum in 3 hours, which is required for design. The individual measured maxima from model tests should generally not be used in design as these vary between different realisations of the same sea conditions, and are therefore unreliable for use as design values.

7.8.2 Maximum values of global loads, motions or accelerations from model test results can be used provided ten similar realisations, or greater, are carried out to ensure that variations between individual tests are accounted for. The mean and standard deviations of the maxima should be calculated. The design value should be the mean plus two standard deviations. Scale effects should also be accounted for by increasing the design loads by a further 10% or a mutually agreed value.

7.9 DEFAULT MOTION CRITERIA

7.9.1 If neither a motions study nor model tests are performed, then for standard configurations and subject to satisfactory marine procedures, the following motion criteria may be acceptable.

Vessel or towed object, type, size and nature of transport	Full cycle period	Single amplitude		Heave
		Roll	Pitch	
Large vessels L ≥ 140 m LOA **and** B ≥ 30 m	10 secs	20°	10°	0.2 g
Medium vessels L ≥ 76 m **and** B ≥ 23 m (other than large vessels)	10 secs	20°	12.5°	0.2 g
Small vessels L <76 m **or** B < 23 m	10 secs	30°	15°	0.2 g
Large cargo barges L ≥ 76 m LOA **and** B ≥ 23 m	10 secs	20°	12.5°	0.2 g
Small cargo barges L <76 m **or** B < 23 m	10 secs	25°	15°	0.2 g
Independent leg jack-ups, field or location move	10 secs	10°	10°	0
Independent leg jack-ups, ocean tow on own hull	10 secs	20°	20°	0
Mat-type jack-ups, field or location move	13 secs	8°	8°	0
Mat-type jack-ups, ocean tow on own hull	13 secs	16°	16°	0
Vessels and barges, weather restricted operations in benign areas (see Section 7.9.2.d)	10 secs	5°	2.5°	0.1 g
Inland and sheltered water transportations (see Section 7.9.2.e)	Static	Equivalent to 0.1 g in both directions		0

7.9.2 The default motion criteria shown in Section 7.9.1, shall only be applied in accordance with the following;

a. Roll and pitch axes shall be assumed to pass through the centre of floatation.

b. Heave shall be assumed to be parallel to the global vertical axis. Therefore the component of heave parallel to the deck at the roll or pitch angles shown above is additive to the forces caused by the static gravity component and by the roll or pitch acceleration.

c. Phasing shall be assumed to combine, as separate loadcases, the most severe combinations of

- roll ± heave
- pitch ± heave

d. The criteria stated for weather-restricted operations in benign areas, are given as general guidance for short duration barge towages and vessel transports. The actual criteria should be agreed with the Noble Denton office concerned, taking into account the nature of the vessel or barge and cargo, the voyage route, the weather conditions, which may be encountered, the shelter available and the weather forecasting services to be utilised.

e. For inland and sheltered water transportations, the loadings caused by a 0.1 g static load parallel to the deck, the static inclination caused by the design wind, or the most severe inclination in the one-compartment damage condition, shall be taken, whichever is the greatest.

f. The additional heel or trim caused by the design wind should be considered. For most transports, it is permissible to omit the effects of direct wind load in computing the forces on the cargo. (See Section 8.3).

7.9.3 Alternative default motion criteria may be acceptable, as set out, for instance, in DNV Rules for the Classification of Ships, January 2003, Part 3, Chapter 1, Section 4 (Ref. 9), or IMO Code of Safe Practice for Cargo Stowage and Securing, 2003 Edition, Section 7 (Ref. 10). Care should be taken to ensure that the criteria adopted are applicable to the actual case in question.

7.10 DIRECTIONALITY AND HEADING CONTROL

7.10.1 The incident weather shall be considered to be effectively omni-directional, as stated in Section 7.4. No relaxation in the design seastates from the bow-quartering, beam and stern-quartering directions shall be considered for;

a. Any transport where the default motion criteria are used, in accordance with Section 7.9, or similar

b. Single tug towages, or voyages by vessels with non-redundant propulsion systems (see Section 7.10.3 below)

c. Any transport where the design conditions on any route sector are effectively beam on or quartering, of constant direction, and of long duration, including, for example, crossing of the Indian Ocean or Arabian Sea in the south-west monsoon

d. Any towage in a Tropical Revolving Storm area and season

e. Any un-manned towage.

f. Any transport where the vessel does not have sufficient, redundant systems to maintain any desired heading in all conditions up to and including the design storm, taking account of the windage of the cargo.

7.10.2 Relaxation in the non-head sea cases may be considered for;

a. Manned, multiple tug towages, where after breakdown of any one tug or breakage of any one towline or towing connection, the remaining tug(s) still comply with the criteria of Section 12.2

b. Voyages by self-propelled vessels with redundant propulsion systems. A vessel with a redundant propulsion system is defined as having, as a minimum;

- 2 or more independent main engines
- 2 or more independent fuel supplies
- 2 or more independent power transmission systems
- 2 or more independent switchboards
- 2 or more independent steering systems, or an alternative means of operation of a single steering system (but excluding emergency steering systems that cannot be operated from the bridge)
- the ability to maintain any desired heading in all conditions up to and including the design storm, taking account of the windage of the cargo.

7.10.3 Any vessel not complying with the above shall be considered non-redundant.

7.10.4 An advance survey may be required, to establish whether or not a vessel can be considered to have a redundant propulsion system.

7.10.5 In general, where a relaxation is allowed in accordance with Section 7.10.2, the following is a guide to the acceptable sea state values. This should be confirmed as being suitable on a case-by-case basis.

Incident angle (Head Seas = 0°)	Applicable $H_{s_{dg}}$ as % of design sea state (adjusted as appropriate)
0° - ± 30°	100%
± (30° - 60°)	Linear interpolation between 100% and 80%
± 60°	80%
± (60° - 90°)	Linear interpolation between 80% and 60%
± 90°	60%
± (90° - 120°)	Linear interpolation between 60% and 80%
± 120°	80%
± (120° - 150°)	Linear interpolation between 80% and 100%
± (150° - 180°)	100%

7.10.6 For any transport where a relaxation is allowed in accordance with Sections 7.10.2 and 7.10.5, a risk assessment shall be carried out.

7.10.7 Such relaxation shall only apply to considerations of accelerations, loads and stresses. It shall not be applied to considerations of stability.

7.10.8 For any transport where a relaxation is allowed in accordance with Sections 7.10.2 and 7.10.5, the towage/voyage arrangements shall contain, in a format of use to the Master;

a. The limitations on critical parameters

b. *Procedures for monitoring and recording of critical parameters*

c. Procedures for heading control

d. Results of the risk assessment, and any recommendations arising

e. Contingency actions in the event of any breakdown.

7.10.9 Critical parameters should preferably be ones the Master can observe or measure.

7.10.10 For any transport where a relaxation is allowed in accordance with Sections 7.10.2 and 7.10.5, *it is strongly recommended that an independent Company (Cargo* Owner's) Representative is on board to witness events. He should be qualified to discuss with the Master weather conditions forecast and encountered, routing advice received and avoidance techniques adopted.

8 LOADINGS

8.1 INTRODUCTION

The structure of the cargo or tow, including the legs, hull and jackhouses of self-elevating units, shall be shown to possess adequate strength to resist the loads imposed due to the specified or calculated motions and wind, combined with the additional loading caused by any overhang of the cargo over the side of the vessel or barge.

The cargo shall be shown to possess adequate strength to withstand the local cribbing and seafastening reactions.

8.2 LOADCASES

8.2.1 Loadcases shall be derived by the addition of fluctuating loads resulting from wind and wave action to static loads resulting from gravity and still water initial conditions.

8.2.2 The fluctuating components shall be the worst possible combination of the loads resulting from calculations or model tests carried out in accordance with Sections 7.1 through 7.8, with due account to be taken of the effects of phase. All influential loadings shall be considered; however the following static and environmental loadings are the most likely to be of importance;

S_1: Loadings caused by gravity including the effects of initial ballast condition

F_1: Loadings caused by static wind heel or trim angle

F_2: Loadings caused by surge/sway acceleration

F_3: Loadings caused by pitch/roll acceleration

F_4: Loadings caused by the gravity component of pitch/roll motion

F_5: Loadings caused by direct wind

F_6: Loadings caused by heave acceleration, including heave.sin(theta) terms

F_7: Loadings caused by wave induced bending

F_8: Loadings caused by slam and the effects of immersion.

8.2.3 Except as noted in Section 7.9.2, the effects of phase differences between the various motions can be considered, if resulting from model test measurements, or if the method of calculation has been suitably validated.

8.2.4 In cases where it is not convenient or possible to determine the relative phasing of extreme wind loadings and heave accelerations with roll/sway or pitch/surge maxima, a reduction of 10 percent may be applied to fluctuating loadcases F1 through F8 which combine maximum wind and wave effects. However, if wind induced or wave induced loads individually exceed the reduce load, then the greatest single effect shall be considered.

8.2.5 Alternatively, the total loads may be calculated by combination of loads as follows;

$$S_1 + F_1(_{1hr}) + F_5(_{1hr}) + \sqrt{\{[F_2+F_3+F_4+F_6]^2 + [F_1(1min)+F5(_{1min})-F_1(_{1hr})-F_5(_{1hr})]^2\}}$$

where;

$F_{(1hr)}$ = Loads based on 1 hour mean wind speed

$F_{(1min)}$ = Loads based on 1 minute mean wind speed.

8.3 DEFAULT MOTION CRITERIA

8.3.1 For loads computed in accordance with Section 7.9, the loads applied to the cargo shall be;

$$S_1 + F_1 + F_2 + F_3 + F_4 + F_6$$

where; S_1, F_1, F_2, F_3, F_4 and F_6 are as defined in Section 8.2.2. The effects of buoyancy and wave slam loading shall also be considered if appropriate.

8.4 LONGITUDINAL BENDING

8.4.1 The potential effects of longitudinal wave bending effects need to be considered if;

a. The towed hull is not a classed, seagoing vessel or barge, or

b. The cargo is longer than about 1/3rd of the transport barge or vessel length, or

c. The cargo is supported longitudinally on more than 2 groups of supports, or

d. The relative stiffness of the hull and cargo could cause unacceptable stresses to be induced in either, or

e. The seafastening design allows little or no flexibility between cargo and barge.

8.4.2 See also Sections 9.3 and 19.4.

8.5 CARGO BUOYANCY AND WAVE SLAM

8.5.1 Cargo overhangs which are occasionally immersed, and which may receive loadings due to wave slam and/or immersion, will require special consideration.

8.5.2 Buoyant cargoes, particularly where the buoyancy contributes to stability requirements, shall be adequately secured against lift-off.

9 DESIGN AND STRENGTH

9.1 COMPUTATION OF LOADS

9.1.1 The loads acting on grillages, cribbing, dunnage, seafastening and components of the cargo shall be derived from the loads acting on the cargo, according to Sections 6, 7 and 8, as applicable.

9.1.2 The loads shall include components due to the distribution of mass and rotational inertia of the cargo. This is of particular importance in the calculation of shear forces and bending moments in the legs of self-elevating units and similar tall structures.

9.1.3 If the computed loads are less than the "Minimum allowable seafastening loads" shown in the Table in Section 9.2.1, then the values in the Table shall apply.

9.1.4 Care should be taken in cases where the cargo may be designed for service loads in the floating condition, but is being dry-transported. Its centre of gravity may be higher above the roll centre in the dry-transportation condition than in any of its floating service conditions. Even though the transportation motions may appear to be less than the service motions, the loads on cargo components and ship-loose items may be greater.

9.2 FRICTION

9.2.1 For certain cargo weights, cargo overhangs and arrangements of cribbing and seafastenings, the effects of friction may be used, as shown in the following Table and subject to Section 9.2.2, to resist part of the computed loadings on the cribbing and seafastenings. This shows the maximum coefficient of friction which may be considered, and the minimum allowable seafastening force, expressed as a percentage of cargo weight, below which the actual seafastening design capability shall not be allowed to fall.

Overhang	Cargo weight, W, tonnes						
	<100	100 ≤W< 1000	1000 ≤W< 5000	5000 ≤W< 10000	10000 ≤W< 20000	20000 ≤W< 40000	≥ 40000
	Maximum allowable coefficient of friction						
None	0	0.10	0.20	0.20	0.20	0.20	0.20
< 15 m	0	0	0.10	0.20	0.20	0.20	0.20
15 – 25 m	0	0	0	0.10	0.20	0.20	0.20
25 – 35 m	0	0	0	0	0.10	0.20	0.20
35 - 45 m	0	0	0	0	0	0.10	0.10
> 45 m	0	0	0	0	0	0	0
Minimum allowable seafastening force, %W							
Transverse	10%	10%	10%	10%	10%	See Note 1	5%
Longitudinal	5%	5%	5%	5%	See Note 2	See Note 3	1.5%

Notes;

1. For 20000 ≤ W < 40000 tonnes, the minimum allowable seafastening force, transversely, shall be not less than 15 - W/4000 (%W)
2. For 10000 ≤ W < 20000 tonnes, the minimum allowable seafastening force, longitudinally, shall be not less than 7.5 - W/4000 (%W)
3. For 20000 ≤ W < 40000 tonnes, the minimum allowable seafastening force, longitudinally, shall be not less than 3.5 - W/20000 (%W)
4. For transport of pipes and similar tubular goods, the above table does not apply. See Section 9.6.

9.2.2 Friction is allowed as a contribution to seafastening restraint subject to the following;

a. Loadings are computed in accordance with Sections 7.2 though 7.8 and 8.2 above. Friction may not be used if the loadings are computed in accordance with Sections 7.9 and 8.3, except as allowed by Section 9.6.

b. Friction forces shall be computed using the normal reaction between the vessel and cargo compatible with the direction of the heave.sin(theta) term used in computing the forces parallel to the deck in Section 8.2.2. Thus, when heave.sin(theta) increases the force parallel to the deck, it also increases the normal reaction and vice-versa.

c. The cargo is supported by wood dunnage or cribbing – friction is not allowed for steel to steel interfaces.

d. The overhang is the distance from the side of the vessel to the extreme outer edge of the cargo.

e. For wood cribbing less than 600 mm high, with a width not less than 300 mm, the full friction force may be assumed to act in any direction relative to the cribbing.

f. For cribbing heights between 600 and 900 mm, with a width not less than 300 mm, then the percentage computed friction force assumed to act in a direction at right angles to the line of the cribbing shall not exceed (900 - H)/3 %, where H = the height of cribbing above deck, mm.

g. For wood cribbing over 900 mm high, or with a width less than 300 mm, no friction force is assumed to act in a direction at right angles to the line of the cribbing.

h. The "*Minimum allowable S/F force*" is the minimum allowable value of seafastening restraint, expressed as a percentage of cargo weight, in the event that the total required seafastening force, as computed, is less than this value.

i. For very short duration moves in sheltered water, such as turning a barge back alongside the quay after a loadout, then friction may be allowed to contribute. The entire load path, including the potential sliding surfaces, shall be demonstrated to be capable of withstanding the loading generated.

9.3 SEAFASTENING DESIGN

9.3.1 In this context, seafastenings include any grillage, dunnage, cribbing or other supporting structure, roll, pitch and uplift stops, and the connections to the barge or vessel.

9.3.2 Seafastenings shall be designed to withstand the global loadings as computed in Sections 7 and 8.

9.3.3 Seafastenings shall be designed to accept deflections of the barge or vessel in a seaway, principally due to longitudinal bending. In general, longitudinal bending should be considered if the distance over forward and aft cargo supports is more than about 1/3rd of barge/vessel length. Some cargoes, such as large steel jackets, may be inherently much stiffer than the barge, and will reduce barge deflections, at the expense of increased cargo stresses.

9.3.4 Where longitudinal bending is a consideration, suitable seafastening designs include;

a. Chocks which allow some movement between the barge and cargo

b. Pitch stops at one point only along the cargo, with other points free to slide or deflect longitudinally

c. Vertical supports at only 2 positions longitudinally

d. An integrated structure of barge-seafastenings-cargo, capable of resisting the loads induced by bending and shear.

9.3.5 Additionally, for towed objects such as EPSOs, which may have permanently installed modules with piping or other connections between them, there should be adequate flexibility in the connections to avoid overstress. It should be noted that the transport wave bending condition may be more severe than the operating condition. In long modules carried as cargo, internal pipework should be similarly considered.

9.3.6 In the absence of more detailed information, it should be assumed that the barge will incur bending and shear deflection as if unrestrained by the cargo. Quasi-static barge hogging and sagging should be considered in a wave of length L equal to the barge length, and height = 0.61√L, metres.

9.3.7 Grillage and seafastening design is frequently influenced by the loadout method. Cargoes lifted onto the transport barge or vessel, or floated over a submersible barge or vessel, are frequently supported by timber cribbing or dunnage to distribute the loads and allow for minor undulations in the deck plating. Cargoes loaded by skidding normally remain on, and are seafastened to, the skidways. Cargoes loaded out by trailers normally need a grillage structure higher than the minimum trailer height. The grillage or cribbing height must allow for any projections below the cargo support line.

9.3.8 Generally, welded steel seafastenings are preferred, but for smaller cargoes, chain or wire lashings with suitable tensioning devices may be acceptable. Guidance on good practice for lashings and similar devices may be found in the IMO Code of Safe Practice for Cargo Securing and Stowing, 2003 Edition (Ref. 10).

9.3.9 Connections to the deck of a barge or vessel should be carefully considered, particularly tension connections. Calculations should be presented to justify all connections. It should not be assumed, without inspection, that underdeck connections between deck plating and stiffeners or bulkheads are adequate. Seafastenings landing on doubler plates are not generally acceptable as tension connections.

9.3.10 If welded steel connections are required in the hold of a vessel, care should be taken to avoid welding onto fuel oil tanks or oil cargo tanks, unless the tanks are empty, and gas free certification has been obtained.

9.3.11 Final welded connections, particularly those which may be influenced by longitudinal deflections of the barge or vessel, should be carried out with the barge or vessel ballasted to the transportation condition, or as close as draft limitations permit.

9.3.12 Welding of seafastenings should not be carried out in wet conditions. Weather protection should be used to minimise the effects of wet conditions.

9.3.13 For cargoes that will be removed offshore, the seafastenings should be capable of being released in stages, such that the cargo is secure for a 10 degree static angle until the release of the final stage. The release of seafastenings, and the removal of any one item, should not disturb the seafastenings of any other item.

9.3.14 Where a lift is made onto a barge offshore, the seafastenings should be designed accordingly, normally by means of guides or a cradle, which will hold the cargo whilst it is being seafastened.

9.3.15 Items of the cargo which are vulnerable to wave action, wetting or weather damage shall be suitably protected. This may require provision of breakwaters or waterproofing of sensitive areas.

9.3.16 Internal seafastenings may be needed to prevent items moving inside structures or modules. See also the caution in Section 9.1.4.

9.4 CRIBBING

9.4.1 Where the cargo is supported on wooden cribbing or dunnage, rather than steel-to-steel supports, then sufficient should be provided to ensure an adequate distribution of load to the underside of the cargo and to the deck of the transport vessel, under the static loadings and the design environmental loadings as shown in Sections 7 and 8.

9.4.2 Cribbing designed to pick up structural members in the underside of the cargo, the transport vessel deck, or both, and fixed to the deck of the vessel, should not normally be less than 200 mm high. See also the comments on cribbing width in Section 9.2.2.f and 9.2.2.g.

9.4.3 A minimum clearance of 0.075 m should be provided between the lowest protrusion of the cargo and the deck of the barge or vessel.

9.4.4 The nominal bearing pressure on the cribbing should not normally exceed 4 N/mm^2 for softwood. Should it be demonstrated that the cargo, vessel and cribbing, without crushing, can withstand a higher pressure, then this may be acceptable. The cribbing pressure should be calculated taking into account the deadweight of the cargo plus the loads caused by the design environmental loadings.

9.4.5 Ideally the type of timber selected should withstand the computed cribbing pressures without crushing. Localised crushing to accommodate cargo and cribbing imperfections is permissible. A satisfactory arrangement may consist of hardwood for the main cribbing structure, topped by a soft packing layer, say 50 mm thick.

9.4.6 In the case of a random or herring-bone dunnage layout supporting a flat-bottomed cargo, without taking into account the strong points, then the maximum cribbing pressures should not exceed 1 N/mm^2, subject to consideration of the overall allowable loads on the deck of the vessel and the underside of the cargo.

9.4.7 For cargoes floated on and/or off the transport barge or vessel, the cribbing should be designed to withstand loads caused by point loads and trim or heel angles during on-load and off-load. A minimum of 5° should be considered.

9.5 STRESS LEVELS IN CARGO, GRILLAGE AND SEAFASTENINGS

9.5.1 The cargo, grillage and seafastenings shall be shown to possess adequate strength to resist the loads imposed during the voyage. Any additional loadings caused by any overhang of the cargo over the side of the transport vessel, buoyancy forces and wave slam loadings shall be included.

9.5.2 The cargo shall be shown to have adequate strength to withstand the local cribbing and seafastening loads.

9.5.3 Stress levels shall be within those permitted by the latest edition of a recognised and applicable offshore structures code.

9.5.4 Extreme loading, i.e loading occurring no more frequently than the maximum design wave, may be assessed as such. Subject to the requirements of Section 9.5.6, in a Working Stress code such as API Recommended Practice 2A-WSD (RP 2A-WSD) Twenty First Edition December 2000 (Ref. 11) the one-third increase for environmental loadings may be applied. Similarly, for an LRFD/partial factor code such as API Recommended Practice 2A-LRFD (RP 2A-LRFD) First Edition, July 1993 (Ref. 12), the load factors would be those used for ultimate limit state (ULS) conditions. These allowable stress levels may be used for connections to the deck of a barge or vessel, but should not include the strength of underdeck members, unless the condition of the entire loadpath has been verified.

Note; If AISC Specification for Structural Steel Buildings, Allowable Stress Design and Plastic Design, June 1989 (Ref. 13) is used with Supplement 1, then a load factor of 0.75 may be adopted. Alternatively, Supplement 1 A4 and A5 may be ignored and the one-third increase applied.

9.5.5 Loadings occurring with a frequency greater than or equal to those associated with the significant design wave shall be treated as normal serviceability limit state (SLS) loadings, with associated load/resistance or safety factors. In a Working Stress code, the one-third increase for environmental loadings shall not be allowed; similarly for an LRFD/partial factor code the load and resistance factors would provide a greater total safety factor than that implicit in the load and resistance factors used for ultimate conditions.

9.5.6 The stress levels allowed by Sections 9.5.4 and 9.5.5 apply only to high quality structural steelwork, with a level of NDT not less than that required by Section 9.7.

9.5.7 Where, for logistical reasons it is impractical to allow the recommended cooling time before inspection of welds then the design stress levels should be reduced.

9.6 SECURING OF PIPE AND OTHER TUBULAR GOODS

9.6.1 This section refers to the transport of tubulars, including line pipe, casing, drill pipe, collars, piles, conductors marine risers and similar (hereafter called "pipes") on vessels and barges. Transport of drill pipe, collars etc on jack-ups is covered in Section 19.11. The degree and design of securing required will depend on the type of vessel, the nature of the cargo, the duration of the towage or voyage, and the weather conditions expected.

9.6.2 For these types of cargoes, friction may be assumed to resist longitudinal seafastening loads, and Sections 9.2.1 and 9.2.2.a do not apply. The following friction coefficients may be used, as examples;

Materials in contact	Friction coefficient
Concrete coated pipe - concrete coated pipe	0.5
Concrete coated pipe - timber	0.4
Timber - timber	0.4
Uncoated steel - timber	0.3
Uncoated steel - uncoated steel	0.15
Epoxy coated pipe - timber	0.1
Epoxy coated pipe - epoxy coated pipe	0.05

9.6.3 Caution should be exercised where sand may be present between the friction surfaces as this may considerably reduce the friction coefficient.

9.6.4 Generally speaking, pipes should be stowed in the fore and aft direction.

9.6.5 Where pipes are stacked in several layers, the maximum permissible stacking height shall be established, in order to avoid overstress of the lower layers. Reference may be made to API RP 5LW - Recommended practice for transportation of line pipe on barges and marine vessels (Ref. 14).

9.6.6 Smaller diameter pipes such as drill pipe may be stacked without individual chocking arrangements, restrained transversely by means of vertical stanchions. Timber dunnage or wedges shall be used to chock off any clearance between the pipes and the stanchions. The stanchions, taken collectively, shall be capable of resisting the total transverse force computed.

a. For weather-restricted operations, and field or location moves of jack-ups, the stack should be secured by means of transverse chain or wire lashings over the top, adequately tensioned. Provided it can be demonstrated that sufficient friction exists to prevent longitudinal movement, no end stops need be provided.

b. For unrestricted operations, including ocean transportations of jack-ups, steel strongbacks should be fitted over the top layer, and the stows set up hard by driving wooden wedges between the strongbacks and the top layer of pipe. End stops or bulkheads shall be provided.

9.6.7 Line pipe on pipe carrier vessels may be stacked between the existing stanchions/crash barriers, on the wooden sheathed deck. Timber dunnage or wedges should be used to chock off any clearance between the pipes and the stanchions.

a. For weather restricted operations, provided it can be demonstrated that adequate friction exists to prevent longitudinal movement, no end stops need be provided. This is likely to apply to concrete coated pipe, but uncoated or epoxy coated pipe should be treated with caution.

b. For unrestricted operations, steel strongbacks should be fitted over the top layer, and the stows set up hard by driving wooden wedges between the strongbacks and the top layer of pipe. End stops or bulkheads shall be provided.

9.6.8 Larger diameter pipes such as piles are often individually chocked, and end stops provided, often at one end only. Unless it can be demonstrated that the piles cannot roll out of the chocks, vertical restraints may be necessary, such as individual wire or chain lashings, or strongbacks.

9.6.9 *In all cases of transportation of coated line pipe, the transportation and securing* arrangements must be designed so that the coating will be protected from damage. The manufacturer's and/or shipper's recommendations should be sought.

9.6.10 Where end stops are provided for pipes with prepared ends, the end preparation should be protected, either with protectors on the pipe, or by wood sheathing on the end stops.

9.6.11 Where open ended pipes are carried on vessels such as supply vessels or pipe carriers, care should be taken that if the pipes can become partially filled with water when the vessel is at sea, the vessel's stability still remains satisfactory, and the lower layers and deck of the vessel are not overstressed. For exposed routes it may be necessary to seal the ends of at least the lowest level of the stack.

9.7 INSPECTION OF WELDING AND SEAFASTENINGS

9.7.1 For newly-constructed cargoes, an adequate system of construction supervision, weld inspection and testing shall be demonstrated. For other cargoes, the extent of inspection and testing shall be agreed.

9.7.2 Principal seafastening welds shall be visually checked and the weld sizes confirmed against the agreed design.

9.7.3 Non-destructive testing (NDT), by a suitable and agreed method, shall be carried out on the structural members of the seafastenings. NDT acceptance criteria should be to *EEMUA 158* - Construction specification for fixed offshore structures in the North Sea (Ref. 15), AWS D1.1 - Structural welding code - steel (Ref .16) or equivalent. The following is a guide to the minimum recommended extent of NDT;

a. 100% visual
b. Penetration welds - 40% UT and 20% MPI
c. Fillet welds - 20% MPI
d. All welds to barge/vessel deck - 100% MPI with additional 40% UT for penetration welds
e. In any case, the extent of NDT should be not less than the Project specification requirements
f. For critical areas, where poor welding quality is suspected, then 100% inspection may be required.

9.7.4 Care should be taken where the seafastening load path depends on the tension connection of the deck plating of a barge or vessel to underdeck stiffeners or bulkheads. In cases of any doubt about the condition, an initial visual inspection should be undertaken, to establish that fully welded connections exist, and that the general condition is fit for purpose. Further inspection may be required, depending on the stress levels imposed and the condition found.

9.7.5 Any faulty welds discovered shall be repaired and re-tested.

9.8 FATIGUE

9.8.1 Notwithstanding the exclusion in Section 4.5.7, clients may wish the effects of fatigue on the towed object, cargo and/or seafastenings to be considered, in which case they should instruct Noble Denton accordingly.

10 STABILITY

10.1 INTACT STABILITY

10.1.1 Intact range of stability, defined as the range between 0° degrees heel or trim and the angle at which the righting arm (GZ) becomes negative, shall not be less than the values shown in the following Table. Objects which do not fall into the categories shown in the Table, which are non-symmetrical, or which have an initial heel or trim which is not close to 0°, may require special consideration. Where there is a significant difference between departure, arrival or any intermediate condition, then the most severe should be considered.

Vessel or towed object, type and size	Intact range
Large and medium vessels, L ≥ 76 m LOA and B ≥ 23 m	36°
Large cargo barges, L ≥ 76 m LOA and B ≥ 23 m	36°
Small cargo barges, L <76 m or B < 23 m	40°
Small vessels, L <76 m or B < 23 m	44°
Jack-ups, field or location moves	28°
Jack-ups, ocean towages	36°
Inland and sheltered water towages	24°

10.1.2 Alternatively, if maximum amplitudes of motion for a specific towage or voyage can be derived from model tests or motion response calculations, the intact range of stability shall be not less than;

$$(20 + 0.8\theta)$$

where θ = the maximum amplitude of roll or pitch caused by the design seastate as defined in Section 6.1.3, plus the static wind heel or trim caused by the design wind, in degrees.

10.1.3 Metacentric height (GM) shall be positive throughout the range shown in Section 10.1.1 or 10.1.2. The initial metacentric height, GM_0, should be adequate to provide positive control with a margin for computational inaccuracy. A GM_0 of around 1.0 m will normally be required, and in any case shall not be less that 0.15 m.

10.1.4 Cargo overhangs shall generally not immerse as a result of heel from a 15 m/s wind in still water conditions.

10.1.5 Subject to Sections 8.5 and 10.1.4, buoyant cargo overhangs may be assumed to contribute to the range of stability requirement of Section 10.1.1.

10.1.6 The effects of free surface shall be considered in the stability calculations. The effects of free surface liquids in the cargo must also be taken into account, as must residual free surface due to incomplete venting when trimmed.

10.1.7 Vessels shall comply with the mandatory parts of the International Maritime Organisation (IMO) Resolution A.749 (18) as amended by Resolution MSC.75(69) - "Code on Intact Stability" (Ref. 17), and the IMO International Convention on Load Lines, Consolidated Edition 2002 (Ref 18).

10.1.8 In areas and seasons prone to icing of superstructures, the effects of icing on stability should be considered.

10.2 DAMAGE STABILITY

10.2.1 Except as described in Sections 10.2.4 and 10.2.5 below, towed objects, including cargo barges, MODUs and structures towed on their own buoyancy, shall have positive stability with any one compartment flooded or breached. Minimum penetration shall be considered to be 1.5 metres. Two adjacent compartments on the periphery of the unit shall be considered as one compartment if separated by a horizontal watertight flat within 5 m of the towage waterline.

10.2.2 The emptying of a full compartment to the damaged waterline shall be considered if it gives a more severe result than the flooding of an empty compartment.

10.2.3 If buoyancy of the cargo has been included to meet intact stability requirements, then loss of cargo buoyancy or flooding of cargo compartments, shall be considered as a damage case, as appropriate.

10.2.4 One-compartment damage stability is not always achievable without impractical design changes, for the following and similar structures;

a. Concrete gravity structures, particularly when towing on the columns
b. Submerged tube tunnel sections
c. Bridge pier caissons
d. Outfall or water intake caissons.

10.2.5 For those structures listed in Section 10.2.4, or similar, damage stability requirements may be relaxed, provided the towage is a one-off towage of short duration, carried out under controlled conditions, and suitable precautions are taken, which may include;

a. Areas vulnerable to collision should be reinforced or fendered to withstand collision from the largest towing or attending vessel, at a speed of 2 metres/second, and;
b. Projecting hatches, pipework and valves are protected against collision or damage from towing and handling lines
c. Emergency towlines are provided, with trailing pick-up lines, to minimise the need for vessels to approach the structure closely during the tow
d. Emergency pumping equipment is provided
e. Potential leaks via ballast or other systems are minimised.
f. Ballast intakes and discharges, and any other penetrations through the skin of the vessel or object, shall be protected by a double barrier system, or blanked off.
g. Vulnerable areas are conspicuously marked
h. Masters of all towing or attending vessels are aware of the vulnerable areas
i. A guard vessel is available to warn off other approaching vessels
j. A risk assessment is carried out.

10.2.6 The extent and adequacy of the precautions necessary for a particular towage will be assessed on a case-by-case basis.

10.2.7 The relaxations allowed by Sections 10.2.4 and 10.2.5 do not apply in ice-affected areas, where the vessel or structure should comply with Section 22.10.

10.2.8 The damage stability recommendations of this Section do not apply to transport of cargoes on registered, classed trading vessels, sailing at the assigned 'B' freeboard or greater. The 'B' freeboard is the minimum freeboard assigned to a Type B vessel, which is generally defined as any vessel not carrying a bulk liquid cargo. Reduced freeboards may be assigned to a Type B vessel over 100 m in length, depending on the arrangements for protection of crew, freeing arrangements, strength, sealing and security of hatch covers, and damage stability characteristics. See the IMO International Convention on Load Lines, Consolidated Edition 2002, (Ref. 15) for further details.

10.3 WIND OVERTURNING

10.3.1 For the intact condition, the area under the righting moment curve, shall be not less than 40% in excess of the area under the wind overturning arm curve. The areas shall be bounded by 0° heel or trim, and the second intercept of the righting and wind overturning arm curves, or the downflooding angle, whichever is less.

10.3.2 The wind velocity used for intact wind overturning calculations shall be the 1-minute design wind speed, as described in Section 6.13.

10.3.3 For the damage condition, the area under the righting moment curve, shall be not less than 40% in excess of the area under the wind overturning arm curve. The areas shall be bounded by the angle of loll, and the second intercept of the righting and wind overturning arm curves, or the downflooding angle, whichever is less.

10.3.4 The wind velocity used for overturning moment calculations in the damage condition shall be 25 metres/second, or the wind used for the intact calculation if less.

10.4 DRAFT AND TRIM

10.4.1 For vessels and barges with a load-line certificate, the draft shall never exceed the appropriate load-line draft, except for temporary on-load and off-load operations under controlled conditions.

10.4.2 The draft should be small enough to give adequate freeboard and stability, and large enough to reduce motions and slamming. Typically, for barge towages, it will be between 35% and 60% of hull depth, which is usually significantly less than the load-line draft.

10.4.3 For barges and large towed objects, such as FPSOs, the draft and trim should be selected to minimise slamming under the forefoot, to give good directional control, and to allow for the forward trim caused by towline pull.

10.4.4 For guidance, and for discussion with the Master of the tug, the tow should be ballasted to the following minimum drafts and trims;

Length of Towed Vessel	Minimum Draft Forward	Minimum Trim by Stern
30 metres	1.0 metre	0.3 metre
60 metres	1.7 metres	0.6 metre
90 metres	2.4 metres	0.8 metre
120 metres	3.1 metres	1.0 metre
150 metres	3.7 metres	1.2 metres
200 metres	4.0 metres	1.5 metres

10.4.5 Where barges with faired sterns are fitted with directional stabilising skegs, it may be preferable to have no trim. However allowance should be made for trim caused by the towline force.

10.4.6 It may be preferable to tow structures such as floating docks, at minimum draft with zero trim, in order to minimise longitudinal bending moments.

10.4.7 Draft marks forward and aft shall be easily readable and, if necessary, re-painted in the area above the waterline.

10.4.8 Where the tow is unmanned, and in order that the tug may monitor any increased draft during the towage, it may be advantageous to paint a broad distinctive line of contrasting colour around the bow approximately 0.5 metre above the waterline.

10.5 COMPARTMENTATION AND WATERTIGHT INTEGRITY

10.5.1 Where the watertight integrity of any tow is in question, particularly for demolition tows, part built ships and MODUs, it shall be checked by visual inspection, chalk test, hose test or air test as considered appropriate by the attending surveyor.

10.5.2 Any opening giving an angle of downflooding less than 20 degrees, or (θ + 5) degrees, where θ is the angle as defined in Section 10.1.2, shall be closed and watertight, or protected by automatic closures in operable condition.

10.5.3 Hatches, ventilators, gooseneck air pipes and sounding pipes shall be carefully checked for proper closure and their watertight integrity confirmed. Where such equipment could be damaged by sea action or movement of loose equipment, then additional precautions should be considered.

10.5.4 Outboard accommodation doors shall be carefully checked for proper closure and their weathertight integrity confirmed. All dogs shall be in good operating condition and seals shall be functioning correctly.

10.5.5 Watertight doors in holds, tween decks and engine room bulkheads, including shaft alleyway and boiler room spaces, shall be checked for condition and securely closed.

10.5.6 Any watertight doors required to be opened for access during the transportation, shall be marked, on both sides, "To be kept closed except for access" or words to that effect. In some cases a length of bar or pipe may be required to assist opening and closing.

10.5.7 Portholes shall be checked watertight. Porthole deadlights shall be closed where fitted. Any opening without deadlights that may suffer damage in a seaway shall be plated over.

10.5.8 Windows which could be exposed to wave action shall be plated over, or similarly protected.

10.5.9 All tank top and deck manhole covers and their gaskets shall be in place, checked in good condition, and securely bolted down.

10.5.10 All overboard valves shall be closed and locked with wire or chain. Where secondary or back-up valves are fitted for double protection, they shall also be closed.

10.5.11 Closure devices fitted to sanitary discharge pipes, particularly near the waterline, shall be closed. Any discharge pipe close to the waterline not fitted with a closure device, may need such a facility incorporated, or be plated over.

10.5.12 All holds, hatch and engine room bilges shall be pumped dry and checked before departure.

10.5.13 All tanks shall be sounded prior to departure. It is recommended that all tanks should be either pressed up or empty. Slack tanks should be kept to a minimum.

11 TRANSPORT VESSEL SELECTION

11.1 GENERAL

11.1.1 The following points should be considered in the selection of a suitable transport barge or vessel;

a. Is there adequate deck space for all the cargo items planned, including room for seafastenings, access between cargo items, access to towing and emergency equipment, access to tank manholes, installation of cargo protection breakwaters if needed, and for lifting offshore if required?

b. Has the barge or vessel adequate intact and damage stability with the cargo and ballast as planned?

c. Does the barge or vessel as loaded have sufficient freeboard to give reasonable protection to the cargo?

d. If a floating loadout is planned, is there sufficient water depth to access and leave the loadout berth? Can the loadout be carried out in accordance with Noble Denton document 0013/NDI - Guidelines for loadouts (Ref. 2)?

e. If a submerged loadout is planned, can the barge or vessel be submerged, within its Class limitation, so as to give adequate clearance over the deck, and adequate stability at all stages, within the water depth limitations of the loadout location?

f. Is the deck strength adequate, including stiffener, frame and bulkhead spacing and capacity, for loadout and transportation loads?

g. For a vessel, does securing of seafastenings require welding in way of fuel tanks?

h. For a barge, is it properly equipped with main and emergency towing connections, recovery gear, pumping equipment, mooring equipment, anchors, lighting and access ladders?

i. Will the motion responses as calculated cause overstress of the cargo?

j. Is all required equipment and machinery in sound condition and operating correctly?

k. Does the barge or vessel possess the relevant, in date, documentation as set out in Section 5?

11.2 SUITABILITY AND ON-HIRE SURVEYS

11.2.1 In his interest, the charterer is advised to have a suitability survey and an on-hire survey of the barge or vessel carried out prior to acceptance of the charter.

12 TUG SELECTION AND APPROVAL

12.1 GENERAL

12.1.1 The tug(s) selected should comply with the minimum bollard pull requirements shown in Section 12.2 below, and should also comply with the appropriate Category in Section 3 of Noble Denton document 0021/NDI - Guidelines for the Approvability of Towing Vessels (Ref. 5). For single tug towages in non-benign areas, tugs in Category ST (Salvage Tug) or U (Unrestricted) will generally be required. In benign areas tugs in Category ST, U or R2 (Restricted Category 2) will generally be required. The appropriate Category should be agreed with the Noble Denton office concerned.

12.1.2 The tug(s) used for any towage to be approved by Noble Denton should be inspected by a surveyor nominated by Noble Denton before the start of the towage. The survey will cover the suitability of the vessel for the proposed operation, its seakeeping capability, general condition, documentation, towing equipment, manning and fuel requirements.

12.1.3 For tugs entered in the Noble Denton Towing Vessel Approvability Scheme (TVAS), it will generally be possible to issue a statement of acceptability in principle, prior to departure. The extent and frequency of surveys as required by the TVAS is defined in Ref. 5. A survey on departure will still be required, to ensure that the vessel still complies with the rules of the scheme.

12.1.4 Vessels not entered into the scheme will require to be surveyed before any formal opinion on acceptability or approvability can be issued. For vessels not known to Noble Denton, a survey well in advance of departure is recommended.

12.2 BOLLARD PULL REQUIREMENTS

12.2.1 For towages where adequate searoom can be achieved within the departure weather forecast and maintained thereafter, and except as allowed or required by Sections 12.2.2, 12.2.3, 12.2.4 or 12.2.5, the minimum towline pull required (TPR) shall be computed for zero forward speed against a 20 metres/second wind, 5.0 metre significant seastate and 0.5 metres/second current acting simultaneously.

12.2.2 For benign weather areas, the criteria for calculation of TPR shall be agreed with the Noble Denton office concerned. Generally these should not be reduced below 15 metres/second wind, 2.0 metres significant seastate and 0.5 metres/second current, acting simultaneously.

12.2.3 For towages which pass through an area of restricted navigation or manoeuvrability, outside the validity of the departure weather forecast and which cannot be considered a weather-restricted operation, TPR should be computed for the design wave height, 1 hour design wind speed and 0.5 metres/second current, acting simultaneously, if this results in a greater TPR than would be obtained by Section 12.2.1.

12.2.4 For towages partly sheltered from wave action, but exposed to strong winds, the criteria shall be agreed with the Noble Denton office concerned.

12.2.5 If the tow route passes through an area of continuous adverse current or weather, or if a particular towing speed is required in calm or moderate weather, a greater TPR may be appropriate. In any event, an assessment should be made that a reasonable speed can be achieved in moderate weather.

12.2.6 TPR shall be related to the continuous static bollard pull of the tug(s) proposed (BP) by;

$$TPR = \Sigma(BP \times T_e/100)$$

where; T_e = the tug efficiency in the sea conditions considered, %
$(BP \times T_e/100)$ is the contribution to TPR of each tug
Σ means the aggregate of all tugs assumed to contribute.

12.2.7 T_e depends on the size and configuration of the tug, the seastate considered and the towing speed achieved. In the absence of alternative information, T_e may be estimated according to the following Table;

Continuous Bollard Pull (BP), tonnes	Te, %		
	Calm	H_{sig} = 2.0 m	H_{sig} = 5.0 m
BP ≤ 30	80	50 + BP	BP
30 < BP < 90	80	80	30 + [0.75 x (BP-30)]
BP ≥ 90	80	80	75

12.2.8 Alternatively, for the Hsig = 5.0 m case, BP can be related to TPR by;

Towline Pull Required (TPR), tonnes	Continuous Bollard Pull (BP), tonnes
TPR ≤ 9	√(100 x TPR)
9 < TPR < 67.5	√[25 + (300 x TPR)/2.25] - 5
TPR ≥ 67.5	TPR/0.75

12.2.9 Only those tugs connected so they are capable of pulling effectively in the forward direction shall be assumed to contribute. Stern tugs shall be discounted in the above calculation.

12.3 MAIN AND SPARE TOWING WIRES AND TOWING CONNECTIONS

12.3.1 The main and spare towing wires, pennants and connections shall be in accordance with Section 13.

12.4 TAILGATES/STERN RAILS

12.4.1 Where a towing tailgate or stern rail is fitted, the radius of the upper rail shall be at least 10 times the diameter of the tug's main towline, and adequately faired to prevent snagging.

12.5 TOWLINE CONTROL

12.5.1 Where a towing pod is fitted, its strength shall be shown to be adequate for the forces it is likely to encounter. It should be well faired and the inside and ends must have a minimum radius of 10 times the towline diameter.

12.5.2 Where no pod is fitted, the after deck should be fitted with a gog rope, mechanically operated and capable of being adjusted from a remote station. If a gog rope arrangement is fitted then a spare shall be carried. Where neither a towing pod or gog rope is fitted, then an alternative means of centring the tow line should be provided.

12.5.3 On square-sterned towing vessels, it is preferred that mechanically or hydraulically operated stops be fitted near the aft end of the bulwarks, to prevent the towline slipping around the tug's quarter in heavy weather.

12.6 WORKBOAT

12.6.1 A powered workboat must be provided for emergency communication with the tow, and must have adequate means for launching in a seaway. An inflatable or RIB may be acceptable provided it has flooring suitable for carriage of emergency equipment to the tow.

12.7 COMMUNICATION EQUIPMENT

12.7.1 In addition to normal Authorities' requirements, the tug shall carry portable marine VHF and/or UHF radios, for communication with the tow when tug personnel are placed on board for inspections or during an emergency. Spare batteries and a means of recharging them shall be provided.

12.8 NAVIGATIONAL EQUIPMENT

12.8.1 Towing vessels shall be provided with all necessary navigational instruments, charts and publications that may be required on the particular towage, including information for possible diversion ports and their approaches.

12.9 SEARCHLIGHT

12.9.1 The tug shall be fitted with a searchlight to aid night operations and for use in illuminating the tow during periods of emergency or malfunction of the prescribed navigation lights. The searchlight(s) should provide illumination both forward and aft, thereby allowing the tug to approach the tow either bow or stern on.

12.10 PUMP

12.10.1 On any tow outside coastal limits, the tug shall carry at least one portable pump, equipped with means of suction and delivery and having a self contained power unit with sufficient fuel for 12 hours usage at the pump's maximum rating. The pump shall be suitable for the requirements outlined in Section 15.2.1.e through 15.2.1.h, but may not be considered to be a substitute for the pump(s) required by Section 15. The methods and feasibility of deployment should be considered.

12.11 ADDITIONAL EQUIPMENT

12.11.1 Anti-chafe gear should be fitted as necessary. Particular attention should be paid to contact between the towline and towing pods, tow bars and stern rail.

12.11.2 All tugs should be equipped with burning and welding gear for use in emergency.

12.12 BUNKERS AND OTHER CONSUMABLES

12.12.1 The tug should carry fuel and other consumables including potable water, lubricating oil and stores, for the anticipated duration of the towage, taking into account the area and season, plus a reserve of at least 5 days supply. If refuelling en route is proposed, then suitable arrangements must be made before the towage starts, and included in the towing procedures.

12.13 TUG MANNING

12.13.1 *Notwithstanding minimum manning levels for tugs as described in Ref. 5, or those* required by State or Port Authorities, consideration shall be given to the fact that in an emergency situation, two or more of the tug crew may need to board and remain on the tow for an extended period. This should be taken into account when approving the manning level of a towing vessel.

13 TOWING AND MISCELLANEOUS EQUIPMENT ON TOW

13.1 TOWING EQUIPMENT AND ARRANGEMENTS - GENERAL

13.1.1 Towage should normally be from the forward end of the barge or tow via a suitable bridle as shown in Appendix A. The components of the system are;

a. Towline connections, including towline connection points, fairleads, bridle legs and bridle apex

b. Intermediate pennant

c. Bridle recovery system

d. Emergency towing gear.

13.1.2 There may be a case for towing some structures by the stern. These could include;

a. Part-built or damaged ships, or any structure when the bow sections could be vulnerable to wave damage.

b. Part-built ships, converted ships or FPSOs without a rudder or skeg, or with a turret or spider fitted forward, where better directional stability may be obtained if towed by the stern.

c. Any structure with overhanging or vulnerable equipment near the bow, which could be vulnerable to wave damage, or could interfere with the main and emergency towing connections.

13.1.3 A risk assessment shall be carried out when making a decision whether to tow by the stern.

13.1.4 If two tugs are to be used for towing, then in general the larger tug should be connected to the bridle, and the smaller tug to a chain or chain/wire pennant set to one side of the main bridle. Alternatively two bridles may be made up, one for each tug. For two balanced tugs, the bridle may be split and the tugs should tow off separate bridle legs, via intermediate pennants. This is not generally preferred for tows with rectangular bows. Whichever system is used, a recovery system should be provided for the connection point for each tug.

13.1.5 For tows where a bridle is not appropriate, such as multiple tug towages, then normally each tug should tow off a chain pennant and an intermediate wire pennant.

13.1.6 It is normal that the towline and the intermediate pennant are supplied by the tug. However, the strength requirements are presented here, to bring together the requirements for towlines and towing connections.

13.2 STRENGTH OF TOWLINE AND TOWLINE CONNECTIONS

13.2.1 The minimum breaking loads (MBL) of the main and spare towlines, and the ultimate load capacity of the towline connections to the tow including each bridle leg, shall be related to the actual continuous static bollard pull (BP) of the tug as follows, (BP, MBL and UTC are in tonnes);

a. Towline breaking load MBL shall be computed as follows;

Bollard Pull (BP)	Benign Areas	Other Areas
BP ≤ 40 tonnes	2.0 x BP	3.0 x BP
40 < BP ≤ 90 tonnes	2.0 x BP	(3.8 - BP/50) x BP
BP > 90 tonnes	2.0 x BP	2.0 x BP

b. The ultimate load capacity (ULC) of towline connections to the tow, including bridle legs, chain pennants, and fairleads, where fitted, shall be not less than;

ULC = 1.25 x MBL, or

ULC = MBL + 40,

whichever is the smaller.

13.2.2 A certificate to demonstrate the MBL of each towline shall be available. MBL may be obtained by testing, or by showing the aggregate breaking load of its component wires, with a spinning reduction factor.

13.2.3 Each bridle leg, and the connections to which it is attached, shall be designed to the full value of ULC, as shown in Section 13.2.1.b.

13.2.4 Fairleads, where fitted, shall be designed as follows, where;

α = the horizontal angle of towline pull,

β = the horizontal angle of a bridle leg, if fitted,

(both related to the nominal towing direction)

ULC is as defined in Section 13.2.1.b.

α	Fairlead ultimate load capacity, resolved as appropriate
$0 \leq \alpha \leq$ (45° or β, whichever is the greater)	ULC
(45° or β, whichever is the greater) < α < 90°	Linear interpolation between ULC and (0.5 x ULC)
α = 90°	0.5 x ULC

13.2.5 Where no fairleads are fitted, the towing connections shall be similarly designed.

13.2.6 For structures such as Concrete GBSs and similar, where it may be operationally necessary to apply the full value of towline pull at any angle, the connections and fairleads may require special consideration, and the reduction shown in Section 13.2.4 may not be appropriate.

13.2.7 Where towing connections or fairleads may be subjected to a vertical load, the design shall take account of the connection or fairlead elevation, the proportion of bridle and towline weight taken at the connection or fairlead, and the towline pull, at the maximum pitch angle computed.

13.2.8 It should be noted that the above requirement represents the minimum values for towline connection strength. It may be prudent to design the main towline connections to allow for the use of tugs larger than the minimum required.

13.2.9 In particular circumstances, where the available towing vessel is oversized with regard to TPR (see Section 12.2), and the towline connections are already fitted to the tow, then the towline connections (but not the towline itself) may be related to the required BP rather than the actual BP. Such relaxation shall be with the express agreement of the Master of the tug, and shall be noted in the towing arrangements.

13.3 RELATIONSHIP BETWEEN TOWLINE LENGTH AND STRENGTH

13.3.1 Except in benign areas and sheltered water towages, the minimum length available of each of the main and spare towlines (L) shall be determined from the "European" formula;

$$L > (BP/MBL) \times 1800 \text{ metres}$$

except that in no case shall the available length be less than 650 metres.

13.3.2 For benign areas, the minimum length available shall be not less than;

$$L > (BP/MBL) \times 1200 \text{ metres}$$

except that in no case shall the available length be less than 500 metres.

13.3.3 The available length shall take into account the minimum remaining turns on the winch drum, and the distance from the drum to the stern rail or roller. One full strength wire rope pennant which is permanently included in the towing configuration may be considered when determining the available length.

13.3.4 MBL as shown in Section 13.2.1 shall be increased if required for L to comply with Section 13.3.1 or 13.3.2 as appropriate. ULC shall be correspondingly increased.

13.4 TOWLINE CONNECTION POINTS

13.4.1 Towline connections to the tow shall be of an approved type. Preferably they should be capable of quick release under adverse conditions, to allow a fouled bridle or towline to be cleared, but must also be secured against premature release. A typical bracket design is shown in Appendix C.

13.4.2 Towline connections and fairleads shall be designed to the requirements of Section 13.2.

13.4.3 Sufficient internal/underdeck strength must be provided for all towline connections and fairleads.

13.4.4 Where fitted, fairleads should be of an approved type, located close to the deck edge. They should be fitted with capping bars and sited in line with the towline connections, to prevent side load on the towing connections.

13.4.5 Where the bridle might bear on the deck edge, the deck edge should be suitably faired and reinforced to prevent chafe of the bridle.

13.4.6 Where towing connections are of a quick-release type, then the fairlead design shall allow all the released parts to pass easily through the fairlead.

13.5 BRIDLE LEGS

13.5.1 Each bridle leg should be of stud link chain or composite chain and wire rope. If composite, the chain should of sufficient length to extend beyond the deck edge and prevent chafing of the wire rope.

13.5.2 The angle at the apex of the bridle should normally be between 45 and 60 degrees.

13.5.3 The end link of all chains shall be a special enlarged link, not a normal link with the stud removed.

13.5.4 All wire ropes shall have hard eyes or sockets.

13.6 BRIDLE APEX

13.6.1 The bridle apex connection should be a towing ring or triangular plate, often called a Delta, Flounder or Monkey Plate, or an enlarged bow shackle.

13.7 SHACKLES

13.7.1 The breaking load of shackles forming part of the towline shall be at least 110% of the **actual** breaking load of the towline to be used.

13.7.2 The breaking load of shackles forming part of the bridle shall be not less than 110% of the **required** breaking load of the connected parts.

13.7.3 If the breaking load of a shackle cannot be identified then the minimum Safe Working Load (SWL) may be related to the continuous static bollard pull (BP) of the largest tug proposed, as follows;

Continuous bollard pull, BP, tonnes	**Minimum Safe Working Load, SWL, tonnes**
BP < 40	1.0 x BP
BP ≥ 40	(0.5 x BP) + 20

13.8 INTERMEDIATE PENNANT

13.8.1 An intermediate wire rope pennant, should be fitted between the main towline and the bridle or chain pennant. Its main use is for ease of connection and reconnection. All wire rope pennants shall have hard eyes or sockets, and be of the same lay (i.e. left or right hand) as the main towline.

13.8.2 A synthetic spring, if used, should not normally replace the intermediate wire rope pennant.

13.8.3 The length of the wire pennant for barge tows is normally 10-15 metres since this can be handled on the stern of most tugs without the connecting shackle reaching the winch. Longer pennants may be needed in particular cases.

13.8.4 The breaking strength of the wire rope pennant shall not be less than that of the main towline with the possible exceptions in Section 13.8.5.

13.8.5 Noble Denton may approve a "fuse" or "weak link" pennant provided that;

a. The strength reduction is not more than 10% of the actual strength of the main towline, and

b. The resulting strength of the pennant is at least equal to that required for the towline.

13.9 SYNTHETIC SPRINGS

13.9.1 Where a synthetic spring is used, its breaking load shall be at least 1.5 times that required for the main towline. As synthetic springs have a limited life due to embrittlement and ageing, they must be in good condition, and have been stored to protect them from wear, solvents and sunlight.

13.9.2 If used, a synthetic spring should normally be connected between the main towing wire and the intermediate pennant, rather than connected directly into the bridle apex.

13.9.3 All synthetic springs shall have hard eyes. A synthetic spring made up as a continuous loop with a hard eye each end is generally preferable to a single line with an eye splice each end.

13.10 BRIDLE RECOVERY SYSTEM

13.10.1 A system shall be fitted to recover the bridle or chain pennant, to allow reconnection in the event of towline breakage. The preferred type of bridle recovery system is shown in Appendix A. It consists of a winch and a recovery line connected to the bridle apex, via a suitable lead, preferably an A-frame.

13.10.2 The recovery winch shall be capable of handling at least 100% of the weight of the bridle, plus attachments including the apex and the intermediate pennant. It shall be suitably secured to the structure of the tow. Except for very small barges, the winch should have its own power source. It should be noted that an adequate winch will be useful for initial connection of the towline. Adequate fuel should be carried.

13.10.3 If the winch is manually operated, it should be fitted with ratchet gear and brake, and should be geared so that the tow bridle apex can be recovered by 2 men.

13.10.4 Should no power source be available, and manual operation is deemed impractical, then arrangements shall be made, utilising additional pennant wires as necessary, which will allow the tug to reconnect.

13.10.5 The breaking load of the recovery wire, shackles, leads etc shall be at least 3 times the weight of the bridle, apex and intermediate pennant. The winch barrel should be adequate for the length and size of the wire required.

13.11 EMERGENCY TOWING GEAR

13.11.1 Emergency towing gear shall be provided in case of towline failure, bridle failure or inability to recover the bridle. Preferably it should be fitted at the bow of the tow. It may consist of a separate bridle and pennant or a system as shown in Appendix B. Precautions should be taken to minimise chafe of all wire ropes.

13.11.2 The emergency system will typically consist of the following;

a. Towing connection on or near the centreline of the tow, over a bulkhead or other suitable strong point

b. Closed fairlead

c. Emergency pennant, minimum length 80 metres, with hard eyes or sockets, preferably in one length. This length may be reduced for small barges and in benign areas

d. Extension wire, if required, long enough to prevent the float line chafing on the stern of the tow

e. Float line, to extend 75-90 metres abaft the stern of the tow

f. Conspicuous pick-up buoy, on the end of the float line. It is advantageous if the buoy is fitted with reflective tape.

13.11.3 The strength of items a, b and c above should be as for the main towline connections, as shown in Section 13.2.1. The breaking load of the handling system, items d and e above should be not less than 25 tonnes, and must be sufficient to break the securing devices.

13.11.4 If the emergency towline is attached forward, it must be led over the main tow bridle. It should be secured to the outer edge of the tow, outside all obstructions, with soft lashings, or metal clips opening outwards, approximately every 3 metres.

13.11.5 If the emergency towing gear is attached aft, the wire rope should be coiled or flaked near the stern, so that it can be pulled clear. The outboard eye should be lead over the deck edge to prevent chafe of the float line.

13.11.6 For towage of very long vessels, alternative emergency arrangements may be approvable but any arrangement shall be agreed with the Master of the tug to ensure that reconnection is possible in an emergency.

13.11.7 Whatever the arrangement agreed, care shall be taken that no chafe can occur to the floating line when deployed.

13.11.8 Swivels are recommended at the connection of the float line to the pennant line or extension wire, and at the connection of the float line to the buoy.

13.11.9 The following reconnection equipment should also be considered, and placed on board if the duration and area of the towage demand it;

a. Heaving lines
b. Line throwing equipment
c. Spare shackles

13.12 CERTIFICATION

13.12.1 Valid certificates shall be available for all chains, wires and shackles utilised in the towing arrangement. Where certification is not available or attainable the surveyor may recommend that oversized equipment shall be fitted.

13.12.2 The Noble Denton surveyor may reject any items that appear to be unfit for purpose, or are lacking valid certification.

13.13 NAVIGATION LIGHTS AND SHAPES

13.13.1 The tow shall carry the lights and shapes required by the International Regulations for Preventing Collisions at Sea, 1972 amended 1996 (COLREGS - Ref. 19) and any local regulations.

13.13.2 Navigation lights shall be independently powered (e.g. from an independent electric power sources or from gas containers). Fuel or power sources shall be adequate for the maximum duration of the towage, plus a reserve. Spare mantles or bulbs should be carried, even if the tow is unmanned.

13.13.3 It is desirable that a duplicate system of lights be provided.

13.13.4 For towed objects which may offer a small response to radar, such as barges or concrete caissons with low freeboard, consideration should be given to mounting a radar reflector. The reflector should be mounted as high as practical. Octahedral reflectors should be mounted in the "catch-rain" orientation.

13.14 ACCESS TO TOWS

13.14.1 Whether a tow is manned or not, suitable access must be provided. This may include at least one permanent steel ladder on each side or stern, from main deck to below waterline.

13.14.2 Where practical, ladders should be recessed, back painted for ease of identification, be clear of overhanging cargo, and faired off to permit access by the tug's workboat.

13.14.3 A pilot ladder on each side or over the stern, secured to prevent it being washed up on deck, may be accepted as a short term alternative, if it can be demonstrated that it will provide a safe and reliable means of access during the towage.

13.14.4 Objects with high freeboard (e.g. over about 10 m) may need special consideration. Ladders should be enclosed, except within 5 m of the towage waterline, with resting platforms every 10 metres. Where practical, stairways are preferable to ladders.

13.14.5 Where practical, a clear space should be provided, with access ladders if necessary, so that in an emergency men may landed or recovered by helicopter. If it is required to land a crew on board prior to entering port, for instance to start pumps and reduce draft, then a properly marked and certified helideck would be an advantage.

13.14.6 A boarding party should be appropriately equipped with survival suits, lifejackets and communication equipment.

13.14.7 Even if the tow is not manned, consideration should be given to placing minimal life saving appliances on board, appropriate to the hazards a boarding party may face once aboard.

13.14.8 Piracy in some areas, for instance South East Asia, is prevalent, and slow moving vessels are particularly at risk. Maintaining sufficient distance from land throughout the tow will reduce this risk and also ensure there is sufficient sea room in case of emergency. Maintaining boarding ladders down to the waterline will make it easier for pirates to board, and consideration should be given to this point. Guidance on prevention of piracy may be found in IMO MSC/Circ.623 - Piracy and armed robbery against ships (Ref. 20).

13.15 MOORING EQUIPMENT

13.15.1 Except for tows, which cannot enter harbour, such as large concrete structures, a suitable number of mooring ropes of adequate length shall be carried aboard the tow fore and aft for use at any arrival port. Mooring ropes shall be in good condition and stowed off the main deck in a protected yet accessible location. See Section 16.7.

13.16 DAMAGE CONTROL AND EMERGENCY EQUIPMENT

13.16.1 When the length and area of the towage demand it, the following equipment should be carried on the tow in suitable packages or in a waterproof container secured to the deck;

a. Burning gear
b. Welding equipment
c. Steel plate - various thicknesses
d. Steel angle section - various sizes and lengths
e. Plywood sheets - 25 mm thick
f. Caulking material
g. Sand and cement
h. Nails - various sizes
i. Wooden plugs – various sizes
j. Wooden wedges – various sizes
k. A selection of tools, including a hydraulic jack, hammers, saws, crowbars
l. Portable coamings 60 cm minimum height, with a flange and boltholes to suit the manhole design. The top should be constructed to avoid damage to hoses and cables
m. A sounding tube extension, of 60 cm minimum height, threaded so that it can be screwed into all sounding plug holes
n. Sounding tapes
o. Fire fighting equipment as appropriate
p. Personal protection equipment - gloves, goggles, hard hats, survival suits etc
q. Emergency lighting.

14 VOYAGE PLANNING

14.1 GENERAL

14.1.1 The following recommendations apply with respect to the way in which the towage or voyage is conducted. The Certificate of Approval is based on agreed towage or voyage arrangements, which shall not be deviated from without good cause, and where practical with the prior agreement of Noble Denton.

14.2 PLANNING

14.2.1 Planning of the voyage or towage shall be carried out in accordance with the requirements of the IMO International Safety Management Code (Ref. 8).

14.3 ROUTEING

14.3.1 Routeing procedures shall be agreed with the Master prior to commencement of the towage or voyage, taking into account the transport vessel or tug's capacity and fuel consumption, the weather and current conditions and normal good navigation and seamanship.

14.4 WEATHER ROUTEING AND FORECASTING

14.4.1 If appropriate, a weather routeing service, provided by a reputable company, should be arranged prior to commencement of the towage or voyage. The utilisation of a weather routeing service may be a requirement of the approval. See also Section 6.3.2. In any event, every effort shall be made by the Master to obtain regular and suitable weather forecasts from a reputable source during the towage.

14.4.2 Weather forecasts for the departure area should be commenced at least 48 hours before the anticipated departure date.

14.4.3 For any towage, the weather conditions for departure from the departure port or any intermediate port or shelter area shall take into account the capabilities of the towing vessel, the marine characteristics of the tow, the forecast wind direction, any hazards close to the departure port or shelter area and the distance to the next port or shelter area. A suitable weather forecast may be one that predicts a minimum 48 hour period with winds not in excess of Beaufort Force 5 and a favourable outlook for a further 24 hours.

14.4.4 Whenever possible a second weather forecast should be obtained from a different independent source prior to departure.

14.5 DEPARTURE

14.5.1 Prior to departure, a departure condition report for the tow or vessel shall be provided by the owners or their agents, for the Master and the Noble Denton surveyor. This report should contain as a minimum;

a. The documentation referred to in Section 5 as appropriate

b. Lightship weight

c. Tabulation and distribution of ballast, consumables, and cargo

d. Calculated displacement and draft

e. Actual draft and displacement

f. For ships, a statement that the longitudinal bending and shear force are within the allowable seagoing limits

g. Calculated VCG

h. Calculated GM

i. GZ Curve.

14.5.2 Departure condition shall be verified to be satisfactory regarding the stability of the tow with proper allowance made for any slack tanks.

14.5.3 If no stability documentation is available then it may be necessary to perform an inclining experiment to check that the GM is satisfactory. Calculations may be needed to establish righting and overturning lever curves.

14.5.4 It shall be verified that the tow floats in a proper upright attitude and at a draft and trim appropriate to the calculated weight and centre of gravity.

14.5.5 The Certificate of Approval shall be issued on agreed readiness for departure and on receipt of a suitable weather forecast.

14.6 PORTS OF SHELTER, SHELTER AREAS, HOLDING AREAS

14.6.1 Ports of shelter, or shelter areas on or adjacent to the route, with available safe berths, mooring or holding areas, shall be agreed before departure.

14.6.2 Where such shelter points are required as part of a weather-restricted operation, as described in Section 6.3, they shall be capable of entry in worsening weather.

14.7 BUNKERING

14.7.1 Bunkering ports, if required, shall be agreed before departure. If it is not practical to take the tow into port, then alternative arrangements must be agreed which may include;

a. Where the towage is by more than one tug, each tug in turn may be released to proceed to a nearby port for bunkers, subject to a favourable weather forecast. The remaining tug(s) should meet the requirements of Section 12.2, or some other agreed criterion.

b. Relief of the towing tug by another suitable tug, which itself is considered suitable to undertake the towage, so that the towing tug may proceed to a nearby port for bunkers.

c. Bunkering at sea from a visiting vessel, subject to suitable procedures and calm weather conditions.

14.7.2 Such procedures shall form part of the approved towage or voyage arrangements.

14.8 ASSISTING TUGS

14.8.1 Assisting tugs shall be engaged at commencement of the towage, at any intermediate bunkering port and at the arrival destination, as appropriate.

14.9 PILOTAGE

14.9.1 The Master shall engage local pilotage assistance during the towage or voyage, as appropriate.

14.10 LOG

14.10.1 A detailed log of events shall be maintained during the towage or voyage.

14.11 INSPECTIONS DURING THE TOWAGE OR VOYAGE

14.11.1 Unless the tow is manned, it should be boarded on a regular basis by the crew of the tug, particularly after a period of bad weather, in order to verify that all the towing arrangements, condition of the cargo, seafastenings and watertight integrity of the tow are satisfactory. Suitable access shall be provided - see Section 13.14.

14.11.2 For manned tows, and self propelled vessels, the above inspections should be carried out on a daily basis as relevant - see also Section 17.5.

14.11.3 Any adjustable seafastenings or lashings should be re-tensioned as necessary.

14.12 REDUCING EXCESSIVE MOVEMENT AND THE SHIPPING OF WATER

14.12.1 The Master should take any necessary measures to reduce excessive movement or the shipping of water which may damage the cargo. This may entail changes of course, or speed, or both.

14.13 NOTIFICATION

14.13.1 After departure of an approved towage or voyage, regular notification shall be sent to Noble Denton regarding progress, the reporting of any unusual or abnormal events, or necessary deviation from the agreed towing arrangements.

14.14 DIVERSIONS

14.14.1 Should any emergency situation arise during the towage or voyage which necessitates diversion to a port of refuge, then Noble Denton shall be advised. Noble Denton will review and advise on the validity of the existing Certificate of Approval for continuing the towage or voyage depending on the circumstances of the case. A further attendance at the port of refuge may be required in order to re-validate the Certificate of Approval.

14.15 RESPONSIBILITY

14.15.1 The Master remains solely responsible for the vessel during the voyage, or for the tug, towing arrangements and tow during the towage. If any special situations arise during the towage or voyage and the Master is unable to comply with any specific recommendations, agreed procedures or International Regulations, then he shall take such measures he deems appropriate for the safety of life and property. Noble Denton shall be informed as soon as practical of any such circumstances.

14.15.2 Nothing in this Document shall set aside or limit the authority of the Master in accordance with maritime laws.

14.16 TUG CHANGE

14.16.1 The tug(s) approved for any towage, as noted on the Certificate of Approval, shall be the only tug(s) approved for that specific towage and should remain with the tow throughout the towage. Should it be required to change the tug(s) for any reason, except in emergency or where special arrangements have been agreed for bunkering, the replacement tug must be approved by Noble Denton and a new Certificate of Approval issued.

15 PUMPING AND SOUNDING

15.1 GENERAL

15.1.1 In general, emergency-pumping arrangements shall be available for any tow.

15.1.2 Pumps in accordance with this section are primarily required for barges. The need for, and specification of, pumps for other tows, including self-floating objects, MODUs, FPSOs and ships, will be assessed on a case-by case basis, depending on the nature of the towage and the extent and availability of any installed system.

15.1.3 Some relaxation may be possible, agreed on a case-by-case basis, for a towage considered as a weather-restricted operation.

15.1.4 Whatever pumping system is agreed, and whether or not a tow is manned, the pumping system shall be available at short notice. Any time required for connection or warm-up should be included in the pumping times and capacities shown in Section 15.5.

15.1.5 Where a tow is not manned, then the tug master and chief engineer shall be aware of the available pumping system. Members of the tug crew shall be familiar with the systems, and be able to board the tow and run the pumps at short notice. Procedures for pumping shall be known and available, including any restrictions arising from considerations of stability or hull stresses, and any vents, which must be opened before pumping starts.

15.2 PURPOSE OF PUMPS

15.2.1 Pumps may be required for the following:

a. Ballasting before, during and after loadouts
b. Ballasting to the agreed departure condition
c. Restoration of draft and trim after discharge (especially at sea)
d. Deballasting to reduce draft to enter port
e. Damage control, including counterflooding
f. Deballasting after accidental grounding
g. Trimming to allow inspection and repair below normal waterline
h. Access to a flooded compartment (e.g. pump room, anchor winch room).

15.2.2 The use of a barge compressed air system may not be practicable for all these cases, especially if manhole covers have been removed, or the barge is holed above the waterline. A compressed air system should have a compressor on board and available, connected into the permanent lines.

15.2.3 It should be possible to sound and pump into or from critical (generally outer) compartments in severe weather. The following shall be provided;

a. Pumping system

b. Watertight manholes

c. Portable coamings

d. Sounding plugs, extensions and tapes or rods. An additional remote sounding system may be needed for compressed air ballasting systems

e. Vents to all compartments.

15.3 PUMPING SYSTEM

15.3.1 It is recommended that barges have one of the following systems, able to pump into and from all critical tanks, in order of preference;

a. Two independent pumprooms or one protected pumproom, as described below

b. An unprotected pumproom with an independent emergency system that can pump out the pumproom

c. A system of portable pumps.

15.3.2 Independent pumprooms should have separate power supply, pumps, control and access. Each pumproom should be able to work into all tanks.

15.3.3 To be considered protected, a pumproom, and any compartment required for access, should be separated from the bottom plating by watertight double bottom plating, not less than 65 cm high, and from the outer shell by other compartments or cofferdams not less than 1.5 metres wide.

15.4 PUMP TYPE

15.4.1 If portable pumps are used then either they should be portable enough to be moved around the barge (and cargo) by two men, or enough pumping equipment should be carried so that any critical compartment can be reached.

15.4.2 Each portable pump should be able to pump out from the deepest tank (with portable coaming installed). This requires submersible pumps for barges over about 6 metres depth, due to suction head. Portable submersible pumps must be able to fit through tank manholes.

15.5 PUMP CAPACITY

15.5.1 The total capacity of the fixed or portable pumps should be such that any one wing tank (or other critical tank or pumproom) can be emptied in 4 hours for an unmanned tow, or 12 hours for a manned tow. At least two pumps shall be provided, except where there is a protected pump room.

15.5.2 Whatever type of pumps are fitted or supplied, sufficient fuel shall be carried for at least 72 hours continuous operation.

15.6 WATERTIGHT MANHOLES

15.6.1 If manholes to critical compartments are covered by cargo then either alternative manholes should be fitted, or cutting gear should be installed and positions marked for making access. Welding gear and materials shall be carried to restore watertight integrity.

15.6.2 Where the barge is classed, the owner should inform the classification society in good time of any holes to be cut or any structural alterations to be made.

15.6.3 Access shall always be available to pumprooms and other work areas.

15.6.4 Ladders to the tank bottom are required from each manhole position.

15.6.5 Suitable tools shall be provided for removal and refastening of manhole covers and sounding plugs. All manhole covers should be properly secured with bolts and gaskets, renewed as necessary.

15.6.6 Portable coamings to suit the manhole design should be carried, if required by Section 13.16.1.

15.7 SOUNDING PLUGS AND TAPES

15.7.1 A sounding plug shall be installed in each compartment (in manhole covers if necessary) to avoid removing manhole covers. For tanks that will be sounded regularly, a tube and striker plate are recommended.

15.7.2 Sounding tapes shall be carried on board the tow.

15.8 VENTS

15.8.1 All compartments connected to a pumping system should have vents fitted, preferably of an approved, automatic, self-closing type. If not automatic, then the vents should be sealed for towage with wooden bungs or steel blanks, but with a 6 mm diameter breather hole fitted. This will give audible warning or reduce pressure differentials in event of mishap, and compensate for temperature changes. The breather hole can be drilled into the gooseneck of the vent or through the wooden bung used to close the vent.

16 EMERGENCY ANCHORS AND MOORING ARRANGEMENTS

16.1 GENERAL

16.1.1 For Classed barges and vessels, the anchor(s) fitted in accordance with Class requirements will generally be acceptable.

16.1.2 For towed ships, including demolition towages, at least one anchor shall be made available for emergency use. If both forward anchors are removed for towing purposes, or if no anchor was originally fitted, then where practical an emergency anchor arrangement should be installed.

16.1.3 For non-classed barges and other towed objects, an emergency anchor shall be fitted where reasonably practical.

16.1.4 For self-elevating platforms, see also Section 19.15.

16.1.5 Where an emergency anchor is not considered practical, alternative arrangements shall be put in place, and a risk assessment carried out. Appendix E sets out topics to be taken into account in the risk assessment.

16.2 SIZE AND TYPE OF ANCHOR

16.2.1 Except for classed barges and other vessels, the weight of the emergency anchor should be 1/10 of the towline pull required (TPR) for the tow, as defined in Section 12.2, with a maximum requirement of 10 tonnes.

16.2.2 A high holding power anchor with anti-roll stabilisation, is preferred.

16.3 ANCHOR CABLE LENGTH

16.3.1 The normal minimum effective length of anchor cable required is 180 metres, preferably mounted on a winch. If the cable runs through a spurling pipe, or other access, to storage below decks, then the pipe or access should be capable of being made watertight.

16.4 ANCHOR CABLE STRENGTH

16.4.1 For cable on a winch, or capstan, which can be paid out under control, the minimum breaking load of the cable should be 15 times the weight of the anchor, or 1.5 times the holding power of the anchor if greater.

16.4.2 For cable flaked out on deck, the minimum breaking load of the cable should be 20 times the weight of the anchor, or twice the holding power if greater, to allow for the extra shock load.

16.4.3 The last few flakes of cable on deck should have lashings that will break and slow down the cable before it is fully paid out.

16.5 ATTACHMENT OF CABLE

16.5.1 The inboard end of the cable should be led through a capped fairlead near the barge centre line and be securely fixed to the barge. Precautions should be taken to minimise chafe of the cable.

16.5.2 The breaking load of the connections of the cable to padeye or winch, and padeye or winch to the barge structure should be greater than that of the cable.

16.5.3 For towed ships, and tows with similar arrangements, the anchor cable(s) shall be properly secured, with the windlass brake(s) applied. Any additional chain stopper arrangements that are fitted shall be utilised, or alternatively, removable preventer wires should be deployed.

16.5.4 Spurling pipes into chain lockers should be made watertight with cement plugs, or another satisfactory method.

16.6 ANCHOR MOUNTING AND RELEASE

16.6.1 If there is no suitable permanent anchor housing the anchor should be mounted on a billboard, as shown in Appendix D, at about 60 degrees to the horizontal.

16.6.2 The anchor should be held on the billboard in stops to prevent lateral and upwards movement. It should be secured by wire rope and/or chain strops that can be easily released manually without endangering the operator.

16.6.3 The billboard should normally be mounted on the stern. It should be positioned such that on release the anchor will drop clear of the barge and the cable will pay out without fouling.

16.6.4 For any system, it shall be possible to release the anchor safely, without the use of power to release pawls or dog securing devices. If the anchor is held only on a brake, an additional manual quick release fastening should be fitted.

16.6.5 The anchor arrangement should be capable of release by one person. Adequate access shall be made available.

16.7 MOORING ARRANGEMENTS

16.7.1 Barges and similar towed objects should be provided with at least four mooring positions (bollards/staghorns etc.) on each side of the barge. If fairleads to the bollards are not installed then the bollards should preferably be provided with capping bars, horns, or head plate to retain the mooring lines at high angles of pull. Suitable chafe protection should be fitted to the deck edge for low angles of pull.

16.7.2 At least four mooring ropes in good condition of adequate strength and length, typically about 50-75 mm diameter polyprop or nylon, and each 60-90 metres long, should be provided. Alternative mooring arrangements may be required for objects with very high freeboard such as FPSOs.

16.7.3 Mooring ropes should be stowed in a protected but accessible position.

16.7.4 Objects with very large freeboard such as FPSOs may advantageously be fitted with mooring and towing connection points along the side, at a convenient height above the towage waterline. These may provide a more convenient connection for mooring lines and harbour tugs than bollards at deck level. Care should be taken that the connection points cannot damage, or be damaged by, attending vessels.

17 MANNED TOWS AND TRANSPORTATIONS

17.1 GENERAL

17.1.1 Manning of tows should generally be limited to those where early intervention by a riding crew can be shown to reduce the risks to the tow, particularly including tows of MODUs, passenger ships and Ro-ro vessels.

17.1.2 Where for instance, a jack-up is transported on a vessel, there is sometimes a requirement for a riding crew on the jack-up, to maintain or commission systems or to carry out general maintenance. A riding crew may be carried on an FPSO for similar reasons.

17.1.3 Where a riding crew is carried on a tow for commissioning and/or maintenance, sufficient marine personnel shall be included to operate the equipment listed in Section 17.4 and to carry out the duties in Section 17.5.

17.1.4 The health and safety of the riding crew is the over-riding concern.

17.1.5 A risk assessment shall be carried out to demonstrate the acceptability of the proposed arrangements.

17.2 INTERNATIONAL REGULATIONS

17.2.1 Accommodation, consumables, lifesaving appliances, pumping arrangements and communication facilities with the tug shall comply with International Regulations.

17.3 SUPERNUMERARIES CARRIED ON THE CARGO

17.3.1 Where a crew is carried on the cargo, for instance a maintenance crew on a dry-transported jack-up rig, the total number of persons on board may exceed the capacity of the vessel. Subject to Flag State approval this may be permissible. Additional precautions which may be necessary include;

a. Access to/from the rig forward and aft, and to the liferaft launching area

b. The rig's liferafts and lifeboats should be relocated if necessary, so that on launching they will land in the water, rather than on the deck of the transport vessel

c. A firewater supply should be made available to the rig.

d. The rig's and vessel's alarm systems should be linked, so that an alarm on the rig is repeated on the vessel, and vice versa.

17.4 SAFETY AND EMERGENCY EQUIPMENT

17.4.1 Notwithstanding the requirements of SOLAS and any or all international regulations for Life Saving Appliances and Fire Fighting Equipment, the minimum complement of safety and emergency equipment carried aboard the tow shall be as follows;

a. Certified liferafts located on each side of the tow, clear of any possible wave action, provided with means of launching and fitted with hydrostatic releases. The liferaft or liferafts on each side of the tow shall be capable of taking the full crew complement. Adequate means of access to the water shall be provided.

b. 4 lifebuoys, two located on each side of the tow and including two fitted with self igniting lights and two with a buoyant line

c. Approved life jackets to be provided for each crew member plus 25% reserve

d. If appropriate, a survival suit to be provided for each crew member

e. First aid kit

f. Fire fighting equipment, which may consist of an independently powered fire pump with adequate hoses, and portable fire extinguishers as appropriate.

g. 6 parachute distress rockets and 6 hand held flares

h. A daylight signalling lamp and battery

i. 2 portable VHF radios, fitted with all marine VHF channels, with appropriate battery charging equipment

j. Hand held GPS receiver

k. GMDSS radio

l. Charts covering the route

m. An EPIRB emergency transmitter

n. 2 SARTs

o. Heaving line(s) and/or line throwing apparatus if appropriate.

17.4.2 All members of the riding crew shall be adequately trained in the use of the safety equipment. At least 1 crew member shall possess the appropriate radio operator's licences.

17.5 MANNED ROUTINE

17.5.1 The riding crew shall take the following actions during the towage;

a. Maintain a daily log and include all significant events

b. Inspect towing arrangements and navigation lights

c. Inspect all seafastenings and any other accessible, critical structures

d. Tension any adjustable seafastenings or lashings as necessary

e. Check soundings of all bilges and tanks

f. Monitor any unexpected or unexplained ingress of water

g. Pump out any ingress of water

h. Maintain regular contact by radio with the tug, reporting any abnormalities.

18 MULTIPLE TOWAGES

18.1 DEFINITIONS

18.1.1 This section covers the following cases of **multiple towages**;

18.1.2 **Double tow** – 2 tows each connected to the same tug with separate towlines. One towline is of sufficient length that the catenary to the second vessel is below that of the first.

18.1.3 **Tandem tow** – 2 (or more) tows in series behind 1 tug, i.e, the second and following tows connected to the stern of the previous one.

18.1.4 **Parallel tow** – the method of towing 2 (or more) tows, using one tow wire, where the second (or subsequent) tow(s) is connected to a point on the tow wires ahead of the preceding tow, and with each subsequent towing pennant passing beneath the preceding tow.

18.1.5 **Two tugs (in series) towing one tow** – where there is only 1 towline connected to the tow and the leading tug is connected to the bow of the second tug.

18.1.6 **More than 1 tug (in parallel) towing one tow** – each tug connected by its own towline to the tow.

18.2 GENERAL

18.2.1 Compared with single towage, multiple towages have additional associated problems including those of;

a. Manoeuvring in close quarter situations
b. Reconnecting the towlines after a breakage
c. Maintaining sufficient water depth for the longer and deeper catenaries required.

18.2.2 Such towages, except as shown in Section 18.1.6, may only be approvable in certain configurations, areas and seasons, and subject to a risk assessment.

18.2.3 When approval is sought, then full details of the operation, including detailed drawings, procedures and equipment specifications shall be submitted to Noble Denton for review and comment. An initial assessment of the method will then be made, and if the basic philosophy is sound, recommendations may be made for the approval process to continue.

18.2.4 Approval may be rejected if any doubt exists as to the viability of the operation proposed.

18.2.5 For those multiple towages that are approvable, each tow shall be prepared as described in these Guidelines.

18.2.6 Additional factors may be applied to the towing arrangements, so that the probability of breakage is further reduced.

18.2.7 The bollard pull requirement of the tug shall be according to the number and configuration of the tows connected. The Towline Pull Required (TPR) should be the sum of those required for each tow. The towing arrangements on each tow shall have sufficient capacity for the Bollard Pull (BP) of the tug.

18.2.8 The tug shall be equipped as in Ref. 5, although additional or stronger equipment and longer towlines may be necessary. Where longer towlines are required, these may be formed by the utilisation of pennant wires of no less Ultimate Load Capacity than the main tow wires.

18.2.9 Where the towing configuration requires the use of 2 towlines from 1 tug, a third tow wire shall be carried on board the tug, stowed in a protected position, whence it can be transferred at sea to either towing winch.

18.2.10 It may be necessary to include chain or a stretcher to improve the spring, or to provide the required catenary in any towing arrangement.

18.2.11 If a synthetic stretcher is included in any towing arrangement, it shall comply with Section 13.9. A spare stretcher shall be carried aboard the tug for each stretcher utilised in the towing arrangement.

18.2.12 Multiple tows being towed behind a single tug may yaw in different directions. Special arrangements shall be made on the deck of the tug to separate the towlines.

18.2.13 It is particularly difficult to reconnect to a tow that has broken loose when another tow or tows are connected to the same tug. Special procedures must be agreed for reconnection.

18.2.14 Due to the difficulties that will be encountered if a towline breakage should occur, Noble Denton may recommend a higher total number of crew on the tug.

18.3 DOUBLE TOWS

18.3.1 These are usually only considered as acceptable;

a. In benign areas

b. For short duration towages covered by good weather forecasts

c. Where there is sufficient water depth along the tow route to allow for the catenary required for the second tow.

18.3.2 The tug should be connected to each tow with a separate towline on a separate winch drum. It shall also carry a spare towline, stowed on a winch, or capable of being spooled onto a winch at sea.

18.4 TANDEM TOWS

18.4.1 These are normally only acceptable in very benign areas or in ice conditions where the towed barges will follow each other.

18.4.2 In ice conditions the towlines between tug and lead tow and between tows will normally be short enough for the line to be clear of the water. Care must be taken to avoid tows over-running each other, or the tug.

18.5 PARALLEL TOWS

18.5.1 This method is generally only approvable in extremely benign areas, and may be subject to additional safety factors with respect to the capacity of the towing arrangements.

18.6 TWO TUGS (IN SERIES) TOWING ONE TOW

18.6.1 This is usually only feasible when a small tug is connected to the bow of a larger, less manoeuvrable tug to improve steering.

18.6.2 This configuration is generally only acceptable if;

a. All the towing gear (towline/pennants/bridles/connections etc.) between the second tug and the tow is strong enough for the total combined bollard pull

b. The second tug is significantly heavier than the leading tug (to avoid girding the second tug).

18.7 MULTIPLE TUGS TO ONE TOW

18.7.1 This is generally considered acceptable, provided that each tug has a separate towline to the vessel (via bridles or pennants as required). Care must be taken that the tugs do not foul each other or their towing equipment.

18.7.2 Consideration should be given to matching the size and power of the tugs.

18.7.3 The use of eccentric bridles may be advantageous but care must be taken to avoid chafe.

18.7.4 Normally there will not be more than 3 tugs, except for the towage of very large objects, such as FPSOs and concrete gravity structures.

19 SPECIAL CONSIDERATIONS FOR THE TRANSPORT OF JACK-UPS

19.1 GENERAL

19.1.1 This Section is intended to cover the special requirements of jack-up platforms, not covered by other sections. The terms field move, location move, ocean towage and ocean transportation have the meanings shown in Section 3.

19.2 MOTION RESPONSES

19.2.1 The motion responses for towage of a jack-up on its own hull, or for transport on a barge or vessel, may be derived from Section 7, either by calculation, from the standard motion criteria in Section 7.9, or by model tests.

19.3 LOADINGS

19.3.1 Loads in legs, guides, jack-houses and jack-house connections into the hull, as appropriate, shall be derived in accordance with one of the methods set out in Section 8.

19.3.2 For jack-ups transported on a barge or vessel, the loads in cribbing and seafastenings shall be similarly derived in accordance with Section 8.

19.4 HULL STRENGTH

19.4.1 For units transported on their own buoyancy, either the hull shall be built to the requirements of a recognised Classification Society, and be in Class, or the requirements of Section 19.4.2 through 19.4.5 shall apply.

19.4.2 If not in Class, the hull shall be demonstrated to be capable of withstanding the following loadings;

a. Static loading, afloat in still water, with all equipment, variable load and legs in towage position, plus either;

b. Longitudinal or transverse bending, as derived from Section 19.4.3, or

c. Loads imposed on the hull and guide support structures by the legs, when subjected to the agreed motion criteria.

19.4.3 Longitudinal and transverse bending may be derived by quasi-static methods, assuming a wave length, L_w, equal to the unit's length or beam, and height;

$$H_w = 0.61\sqrt{L_w},$$

where L_w is in metres.

19.4.4 External plating shall be demonstrated to have adequate strength to withstand the hydrostatic loads due to the immersion of the section of shell plating considered, to a depth equivalent to that which would be caused by inclining the hull, in towage condition, to the static angle equal to the amplitude of motion as considered in Section 7.9.1.

19.4.5 Hull and superstructure construction, details, materials and workmanship shall be shown to be in accordance with sound marine practice, and shall be in sound condition.

19.5 STRESS LEVELS

19.5.1 Stress levels in legs, guides, jack-houses, hull and all temporary securing arrangements shall comply with Section 9.5. See also the caution in Section 9.1.4.

19.5.2 A critical motion curve may be drawn up, or provided in the Operations Manual, reflecting the motion limits for the legs or any other component. This may be used as a guide during the towage or voyage, indicating whether course or speed should be changed, or the legs lowered, as appropriate.

19.5.3 Prior to an ocean transportation of a jack-up, an inspection programme, including non-destructive testing, for critical structural areas should be implemented. Typically, this should include, as appropriate, the areas of legs from just below the lower guides to 2 bays above the upper guides, with the legs in any proposed transport condition. It should also include the guide connections, the jack-house connections to the deck and connections of the spudcans to the leg chords.

19.5.4 The exclusion stated in Section 4.5.7 regarding fatigue damage should be noted. Local areas of jack-up platforms may be particularly prone to fatigue damage. The effects of fatigue damage will be excluded from any Certificate of Approval issued by Noble Denton unless specific instructions are received from the client.

19.6 STABILITY AND WATERTIGHT INTEGRITY

19.6.1 For units transported on their own buoyancy, the following shall apply;

a. The intact stability requirements set out in Section 10.1 and 10.3.

b. The damage stability requirements of Sections 10.2 and 10.3.

19.6.2 For ocean towages, the compartmentation and watertight integrity requirements of Section 10.5 shall be particularly addressed. Engine room intake vents and exhausts, shall comply with Section 10.5.2. Other special considerations for jack-ups include;

a. All compartments and their vents, intakes, exhausts and any other appurtenances or openings shall be effectively watertight up to the waterline associated with the minimum required downflooding angle (see Section 10.5.2), or 3 m above main deck level, whichever is the higher.

b. All compartments and their vents, intakes, exhausts and any other appurtenances or openings shall be structurally capable of withstanding hydrostatic pressure due to inclination to the minimum required downflooding angle, and direct loadings from green water.

c. All air intakes and exhausts for equipment that must be kept running and/or which must be available for emergency use must extend above the waterline associated with the minimum required downflooding angle, or 3 m above main deck level, whichever is the higher.

d. Any jetting lines and pumping nipples in lines shall be checked closed and watertight before departure.

e. All pre-load dump valves shall be closed and secured.

f. Mud return lines from shale shaker pumps etc, leading below main deck, shall be blanked off.

g. Dump valves in mud pits shall be checked closed secured.

h. Overboard discharges shall be blanked off, or fitted with non-return valves.

19.6.3 For all towages, liquid variable loads shall be minimised and shall be in pressed up tanks where possible.

19.6.4 Free surface in the mud pits is not generally acceptable, except for very short field moves in controlled conditions.

19.6.5 Free surface effects of all remaining liquid variables, except those in pressed up tanks, shall be taken into account in the stability calculations.

19.6.6 Stability calculations shall accurately reflect the position and buoyancy of the spud cans. Spud can water shall be taken into account in weight and centre of gravity calculations, where appropriate.

19.7 TUGS, TOWLINES AND TOWING CONNECTIONS

19.7.1 Tugs shall be selected in general accordance with Section 12.

19.7.2 For ocean towages, towing vessels in Category ST or U, as shown in Ref. 5 will generally be required. For field and location moves, towing vessels in Category R1 or R2, may be acceptable.

19.7.3 The particular requirements for manoeuvring on and off location should be taken into account when selecting the towing fleet.

19.7.4 Towlines and towing connections shall, as a minimum, be in accordance with Section 13. The cautions in Section 13.2.8 and 13.2.9 should be noted.

19.7.5 For field or location moves by multiple tugs, where the unit is manned, emergency towing gear as shown in Section 13.11 may not be required.

19.8 SECURING OF LEGS

19.8.1 For ocean transportations, legs shall be properly secured against excessive horizontal movement by means of shimming in the upper and lower guides, or by means of an approved locking device. Shim material specification should take into account the pressures expected, particularly for units with guides having a small contact area.

19.8.2 For field and location moves, leg position and securing arrangements shall be agreed, and shall comply with designers' recommendations.

19.8.3 For electric jacking systems, all motors should be checked for torque and equalised in accordance with manufacturers' instructions.

19.8.4 Hydraulic and pneumatic jacking systems shall be secured in accordance with manufacturers' recommendations.

19.8.5 For tilt-leg jacking systems, tie bars shall be fitted to by-pass the tilt mechanism.

19.8.6 Where lowering of legs or jacking on a standby location is envisaged during the towage, then any leg securing arrangements shall be quickly removable.

19.8.7 Where a critical motion curve, or equivalent limitation, is provided for the legs, it may be necessary to lower the legs in order to comply. Instructions and limitation for this operation shall be clearly defined in the Operations Manual, taking into account any lesser motion limitation during the lowering operation. The lowering operation shall be carried out well before the onset of forecast bad weather.

19.9 DRILLING DERRICK, SUBSTRUCTURE AND CANTILEVER

19.9.1 The drilling derrick, substructure and cantilever shall be shown to be capable of withstanding the motions as derived from Sections 7 and 19.2. For field moves the crown block is to be in place. For ocean transportations the derrick shall be considered in the condition proposed for transportation, with the crown block lowered if required. Other machinery and equipment are to be similarly considered.

19.9.2 For ocean transportations and location moves, no setback shall be carried.

19.9.3 For field moves, towage with setback in the derrick may be considered, provided it can be demonstrated that;

a. The derrick, with the setback proposed, can withstand the motion criteria derived from Section 19.2.

b. All pipe, collars or other equipment racked in the derrick is secured to meet the same criteria.

c. The stability of the unit can meet the requirements of Section 19.6.

d. The carriage of setback in the derrick is clearly documented. The limitations thereof, the securing method, and any special precautions shall be clearly stated.

19.9.4 For ocean transportations the travelling block should be lowered and secured. The drill line should be tightened, and secured against movement.

19.9.5 The upper skid unit shall be secured.

19.9.6 The cantilever substructure shall be skidded to the approved position for tow, and secured.

19.9.7 Hydraulic skidding systems shall be secured in accordance with manufacturers' recommendations.

19.10 HELIDECK

19.10.1 For ocean towages, it shall be shown that at an inclination in still water of 20 degrees about any horizontal axis, no part of the helideck plating or framing is immersed.

19.10.2 Alternatively, model tests may be used to demonstrate that the helideck remains at least 1.5 m clear of wave action, in any seastate up to the design seastate as defined in Section 6.

19.10.3 If neither Section 19.10.1 nor 19.10.2 can be satisfied, then all or part of the helideck shall be removed for the towage.

19.11 SECURING OF EQUIPMENT AND SOLID VARIABLE LOAD

19.11.1 Weight of equipment variable load carried on board shall not exceed the maximum variable load allowed for jacking.

19.11.2 All items of equipment above and below decks shall be secured to resist the motions indicated in Sections 7 and 19.2.

19.11.3 For field and location moves, drill pipe, collars and other tubulars shall be properly stowed on the pipe deck and in the bays provided with stanchions erected. Chain lashings over each stack shall be used. See also Section 9.6.

19.11.4 For ocean transportations, drill pipe, collars and other tubulars shall be stowed in the piperacks, to a height above the rack beams of no more than 1.8 metres. Drill pipes should normally be stowed on top of collars. Timber battens should be placed between each layer of pipe. See also Section 9.6.

19.11.5 For ocean transportations, the well logging unit shall be secured in position and stops fitted to prevent rotation.

19.11.6 All crane booms shall be laid in secure boom rests. For ocean transportations, the booms should be shimmed or wedged against transverse and vertical movements, but left free to move axially. Fitted brake systems for prevention of crane rotation shall be implemented. Electric power shall be isolated at main switchboard. Cranes shall not be used at sea.

19.11.7 Deepwell and leg well pumps shall be fully raised and secured.

19.12 SPUD CANS

19.12.1 For field and location moves, the spud cans should normally be full. See also Section 19.6.6.

19.12.2 For ocean towages, the spud cans may be full or empty. See also Section 19.6.6. If empty, and if the towage procedures call for lowering of legs (see Section 19.8.6), then the lowering procedures must include procedures for filling the spud cans.

19.12.3 For dry transports, the spud cans should be empty and vented. Safety notices should be posted at each spudcan, and at the control panel.

19.13 PUMPING ARRANGEMENTS

19.13.1 For units transported on their own buoyancy, the general requirements of Section 15 shall apply. The requirements of Sections 19.13.2 and 19.13.3 shall also apply.

19.13.2 All tanks should be capable of being pumped by the unit's own pumping systems. Sufficient generator capacity should be available to operate bilge and ballast systems simultaneously.

19.13.3 Additionally for ocean towages, 2 no x 3 inch portable, self-contained, self-priming salvage pumps shall be on board, with not less than 30 metres each of suction and delivery hose.

19.14 MANNING

19.14.1 Units transported on their own buoyancy should usually be manned, and the general requirements of Section 17 shall apply.

19.14.2 Units transported on a barge or vessel need not be manned. However, it may be advantageous for person(s) familiar with the unit's structure, machinery and systems to be on board the tug or the transport vessel, and to inspect the unit periodically.

19.14.3 Protection of Machinery

19.14.4 Where practical, and where the unit is manned, main and auxiliary machinery should be run periodically during the transportation.

19.14.5 For ocean transportation, electrical equipment which cannot be run, including motors, switchgear and junction boxes, should have dehumidifying chemicals placed inside, and then be wrapped against wetting damage. Heaters, where fitted, should be run periodically.

19.15 ANCHORS

19.15.1 The general requirements of Section 16 shall apply.

19.15.2 It is anticipated that most jack-ups will have 4 anchors, 2 forward and 2 aft.

19.15.3 For field and location moves, all 4 anchors shall be in place, and operable.

19.15.4 For ocean towages, the forward anchors should normally be removed, and secured on deck. The aft anchors should be left in place and stopped on the racks to prevent lateral movement. A retaining wire tightened by a turnbuckle and incorporating a quick-release system should be passed through the anchor shackle and secured on deck. The turnbuckle and quick-release system shall be on deck and accessible.

19.16 SAFETY EQUIPMENT

19.16.1 For towages on a unit's own buoyancy, safety equipment in accordance with SOLAS and any or all regulations for Life Saving Appliances and Fire Fighting Equipment shall be carried. Consideration should be given to any additional equipment listed in Section 17.4.1.

19.16.2 For ocean towages, it may be necessary to relocate liferafts stowed forward to a secure area protected from wave action. Securing arrangements for liferafts stowed aft should be checked.

19.17 CONTINGENCY STAND-BY LOCATIONS

19.17.1 Where the towing arrangements envisage jacking up at any intermediate location, suitable procedures shall be written to cover location feasibility, preloading requirements, airgap requirements, local clearances and Customs formalities etc.

20 SPECIAL CONSIDERATIONS FOR THE TOWAGE OF SHIPS

20.1 GENERAL CONSIDERATIONS

20.1.1 This Section sets out the technical and marine aspects, which would be considered by Noble Denton for approval of the towage of ships, including demolition towages and as appropriate, towages of FPSOs.

20.1.2 It is recognised that all ships are different and these guidelines are therefore general in nature. Each specific approval depends on a survey to identify any particular problems which may exist for the vessel(s) in question.

20.1.3 It is preferred that any towed vessel should be in Class with a recognised Classification Society, and possess a current Load Line or Load Line Exemption Certificate. It is recognised that for demolition towages, the Class and other documentation may have expired, and renewal may be impractical. Minimum requirements are shown in Section 5.

20.1.4 The existence of current classification and certification will be taken into account when determining the extent of survey required.

20.1.5 After carrying out an inspection, and in order to verify that the structural strength and watertight integrity of the tow is approvable for the intended voyage, the attending surveyor may require one or more of the following;

a. An extended, in depth, survey of the vessel structure involving one or more specialist surveyor(s). Facilities for close up survey of inaccessible parts of the hull structure may be required.

b. Thickness determination (gauging) of specified areas of the vessel structure. This survey may be in limited areas or extend over large parts of the hull structure. Such surveys shall be carried out by a reputable independent company. An existing survey report may be acceptable provided that it is not more than 1 year old, and there is no evidence of damage or significant deterioration since that date.

c. A Noble Denton review of classification society approved scantling drawings.

d. Calculations to show that the structural strength of particular local areas of the vessel is adequate. The extent of the calculation required to be determined by the results of the surveys.

20.1.6 Should any doubt exist as to the ability of the vessel to complete the proposed towage, after all the necessary surveys and calculations have been undertaken, a dry dock survey of the vessel may be necessary.

20.1.7 After complying with the requirements of Sections 20.1.2 through 20.1.6 above Noble Denton may deem that the vessel is unfit for tow and decline to issue a Certificate of Approval. Alternatively the vessel may only be considered fit for tow after specified repairs or temporary strengthening have been carried out.

20.1.8 The towage of any vessel which is damaged below the waterline, is suspected of being damaged below the waterline or has suffered other damage or deterioration which could affect the structural strength will not normally be approved except where it is clearly shown by survey and calculation that the strength of the vessel and its watertight integrity is satisfactory for the intended towage.

20.1.9 Passenger ships and warships, because of the complex nature of their systems, pose particular problems with respect to their compartmentation, and require special consideration. Ro-ro ships may also pose particular problems, on account of the potentially large free surface in the event of flooding. Passenger ships and Ro-ro ships will generally only be approved for towage if the tow is manned, to permit early intervention in the event of any problems.

20.1.10 Any heavy fuel oil within the tanks of the vessel must be identified, and shall be minimised where possible. In the event of heavy fuel oil being carried, possible limitations on entry to ports of refuge and ports of shelter shall be noted and taken into account in the towage procedures. To minimise the risk of pollution, the requirements of the IMO "Guidelines for Safe Ocean Towing" (Ref. 21), paragraph 13.19, shall be taken into account so far as is practical.

20.1.11 These guidelines assume that the tow will be towed from its forward end or bow. If a stern-first towage is required then approval may be given and the basic guidance contained in this report is valid. In this case, and depending on the circumstances, special care shall be taken regarding towing connections, draft, trim and the control and protection of the tow during the towage. See also Section 13.1.2.

20.2 TUG SELECTION

20.2.1 Tug selection, including specification and bollard pull, shall be in accordance with Section 12.

20.3 TOWLINES AND TOWING CONNECTIONS

20.3.1 Each ship or vessel towage is unique and it is therefore not possible to specify the connection equipment to be used and how it is to be attached for every case. The guidelines hereunder are therefore general in nature. In any event, any equipment used for the towage must be fit for purpose and must be agreed between the Owner of the tow, the tug master and the Noble Denton surveyor.

20.3.2 Towlines, towline connections, recovery systems and emergency towing gear shall be in general accordance with Sections 13.1 through 13.12.

20.3.3 Unless the tow has been fitted with proper towing brackets, or the anchor chain and windlass are used, it may be necessary to utilise attachments such as mooring bitts to connect to the tow. In such cases it shall be shown that the mooring equipment has sufficient ultimate strength, above and below deck, to comply with Section 13.2.1. If necessary, reinforcements shall be fitted to achieve the required capacity, otherwise alternative arrangements must be made.

20.3.4 The configuration of the attachments to the tow may be one of the following depending on the circumstances and equipment available;

a. Chain bridle with bridle leg from each side of the bow
b. Single chain from centre line location or forward fairlead
c. Anchor chain(s) from vessel's hawse pipe(s)
d. Single continuous chain with the ends extending out from each bow
e. Single continuous chain, or chain and wire combination, around a part of, or the whole superstructure of the vessel.

20.3.5 Chain may be substituted by wire rope of the required ultimate load capacity, but only where chafe cannot occur.

20.3.6 A bridle is most suitable for tows which have a wide bow. In any event the angle at the apex of the bridle should not exceed 60°. A triangle plate, delta plate or towing ring shall be fitted at the apex of the bridle.

20.3.7 For tows which have a sharp bow configuration a single chain pennant passing through a bow centre line or forward fairlead may be preferred.

20.3.8 If deemed appropriate an anchor chain from the tow may be used after removal of the associated anchor. The condition and capacity of the chain shall be assessed with reference to Section 13.2. If such a method is utilised then appropriate safety measures shall be applied as follows;

a. Windlass in gear

b. Windlass brake applied

c. Chain claw or stopper deployed

d. Back-up wire to connect chain to base of windlass or other suitable securing point.

20.3.9 A single chain passing through one side fairlead, around a strongpoint such as the windlass base and out of a fairlead on the other side may be approvable. An alternative arrangement may consist of a single chain passing up one hawse pipe and out of the other. In either case the outboard ends should be made up into a bridle. Each leg should have preventers on the inboard side to stop the chain sliding and it should not interfere with the vessel's emergency anchoring arrangements.

20.3.10 On a vessel which is not provided with suitable attachments, or where the anchoring arrangements do not permit the single chain method described above, a chain, or a combination of chain and wire may be positioned around a part of, or the whole superstructure of the vessel and made up into a bridle at the bow.

20.3.11 Where mooring bitts are utilised to secure chain to the tow, and in order to ensure that the towing arrangement is securely anchored on the vessel and does not slip on the bitts, the chain should be backed-up to further bitts abaft the main connection points using suitable wire pennants locked into position with clips. If such an arrangement is used then the first bitts used must have the required ultimate capacity, unless positive load-sharing can be achieved. Bitts and fairleads shall be capped with welded bars or plates of sufficient strength to prevent equipment jumping off or out of the arrangement.

20.4 STABILITY, DRAFT AND TRIM

20.4.1 Stability, draft and trim shall be in accordance with Sections 10.1 through 10.4.

20.5 COMPARTMENTATION AND WATERTIGHT INTEGRITY

20.5.1 Compartmentation and watertight integrity shall be in accordance with Section 10.5.

20.6 ANCHORS

20.6.1 At least one anchor shall be made available for use in an emergency, as shown in Section 16.

20.6.2 If both forward anchors are removed for towing purposes, or if no anchor was originally fitted, then where reasonably practical, an emergency anchor arrangement should be installed and appropriate access afforded for deployment by one person.

20.6.3 Port and starboard anchor cables shall be properly secured with the windlass brake applied. Any additional chain stopper arrangements that are fitted shall be utilised or, alternatively, removable preventer wires shall be deployed.

20.6.4 Spurling pipes into chain lockers shall be made watertight with cement plugs or other satisfactory method.

20.6.5 Where an emergency anchor is not considered practical, alternative arrangements shall be put in place, and a risk assessment carried out. Appendix E sets out topics to be taken into account in the risk assessment.

20.7 SECURING OF EQUIPMENT AND MOVEABLE ITEMS

20.7.1 In general, all equipment shall be secured to meet the appropriate motion requirements of Section 7, and seafastenings of loose items designed in accordance with Sections 8 and 9.

20.7.2 All crane booms and lifting derricks shall be laid in secure boom rests. For ocean transportations, the booms should be shimmed or wedged against transverse and vertical movements, but left free to move axially. Fitted brake systems for prevention of crane rotation shall be implemented. Electric power shall be isolated at main switchboard. Cranes shall not be used at sea.

20.7.3 The rudder shall be positioned in the amidships position, or as agreed with the Tug Master, and immobilised.

20.7.4 The propeller shaft shall be immobilised, or disconnected, to prevent damage to machinery during the towage.

20.7.5 Every effort shall be made to limit the carriage of any loose deck equipment to an absolute minimum. Where equipment must be carried on an exposed deck then it shall be protected and secured against movement using welded brackets, chain or wire. Equipment in other areas shall also be secured.

20.7.6 For large equipment, engineering calculations shall be carried out in order to verify that the securing of items is satisfactory.

20.7.7 Additional protection or securing may be required for equipment exposed to wave slam.

20.8 EMERGENCY PUMPING

20.8.1 Emergency pumping arrangements shall be available on the tow, in general accordance with Section 15.

20.9 CARRIAGE OF CARGO

20.9.1 The carriage of manifested cargo on the tow shall not normally be approved unless the tow is manned and is fully classed by a Classification Society, including the possession of a current International Load Line Certificate.

20.9.2 International Load Line Regulations shall be strictly followed. Approval shall not be given to any towage where the prescribed Load Line draft is exceeded.

20.9.3 A cargo plan shall be provided for agreement by the attending surveyor.

20.9.4 The cargo shall be loaded in a seaman-like manner making proper allowances for load distribution both during loading and for the duration and route of the towage. Longitudinal strength requirements shall be complied with.

20.9.5 Bulk cargoes shall be properly trimmed to prevent shifting in a seaway. Shifting boards or other preventative methods shall be utilised where appropriate.

20.9.6 All other cargoes shall be secured in accordance with Sections 7, 8 and 9.

20.9.7 Particular attention shall be paid to the securing of scrap steel, which if carried shall be properly seafastened. If carried in a hold, it shall not be treated as a bulk cargo.

21 SPECIAL CONSIDERATIONS FOR THE TOWAGE OF FPSOS

21.1 GENERAL AND BACKGROUND

21.1.1 Many of the foregoing guidelines apply equally to the towage of FPSOs, and similar large vessels. The aim of this Section is to address the specific marine-related issues associated with the towage of these units. Although it is recognized that there are many more marine activities in an FPSO development, towage to field is a critical and often long operation, which must be addressed by the project team early in the schedule.

21.1.2 Some FPSO developments are 'fast-track', resulting in construction and commissioning activities being completed during the tow.

21.1.3 New-build or converted FPSOs usually undertake a limited number of towages only, following construction or conversion. There may be a further towage at the end of their working life.

21.1.4 Frequently the design weather conditions for towage are more severe than the service conditions. There is a natural reluctance to build in additional strength or equipment which will have no practical value during the service life.

21.1.5 Project-specific fit-for-purpose guidelines must be agreed in each case.

21.2 TOWAGE MANUAL

21.2.1 A comprehensive Tow Manual shall be written to identify all aspects of the towage in detail, cover all likely contingencies and specify exactly how the towage will be conducted.

21.2.2 If the tow to field and the installation are performed by different contractors, then the scope split between the contractors must be clearly defined, to ensure that all parties are aware of their responsibilities, handover points and reporting lines.

21.3 THE ROUTE AND WEATHER CONDITIONS

21.3.1 Metocean design criteria should be carefully established early in the project, in accordance with Section 6. In many cases, the field's operational criteria may be less onerous than the tow-to-field criteria, so temporary-phase operational limits may define structural load cases and equipment motion criteria.

21.3.2 Mitigation of the design extremes may be achieved by the use of a staged towage, in accordance with Section 6.3.

21.3.3 In such cases the towage route must be planned to incorporate a series of safe-havens, meaning sheltered locations where the tow can safely ride out severe weather. It may also be necessary to identify suitable bunker ports. These requirements may conflict with the requirement for adequate searoom, and such conflicts should be resolved.

21.3.4 Passage through restricted or busy waters should be considered, and the need for appropriate additional tugs determined.

21.4 STRUCTURAL ISSUES

21.4.1 FPSOs are intended to remain at sea without drydocking for their entire working life, usually in the order of 20 years. In this respect the integrity of the hull must be maintained and precautions taken to ensure no damage occurs during the tow. A commercial vessel is usually assumed, for design purposes, to spend about 20% of its life in port, and is periodically dry-docked. These differences place much greater emphasis on the reliability, integrity and quality of the hull including its coating. These qualities must not be compromised during the tow other than by reasonable wear and tear.

21.4.2 For long towages, fatigue damage may need to be considered.

21.4.3 Global deformations (hogging, sagging, torsion) of the hull under the design environmental conditions shall be checked.

21.4.4 Equipment foundations shall be designed for the temporary phase operations. Fatigue damage to the connections between the topsides and hull should be considered.

21.4.5 Any temporary equipment aboard shall be secured in accordance with the design environmental conditions. If construction, completion, or commissioning work is performed during tow, then all the scaffolding, temporary power packs, work containers etc shall be installed to withstand the design criteria. Any scaffolding or other temporary works which cannot comply with the design criteria shall be dismantled or removed.

21.4.6 Greenwater damage or slamming damage on temporary equipment should be considered in the location of equipment.

21.5 TUG SELECTION

21.5.1 Tugs shall be selected, as a minimum, in accordance with Section 12, but with regard to the comments on redundancy below.

21.5.2 Redundancy in the towing fleet is recommended.

21.5.3 The use of additional tug(s) may be required in restricted waters.

21.5.4 Redundancy of towing vessels gives greater freedom for bunkering, where one tug may divert to bunker whilst the other(s) continue(s) with the towage.

21.5.5 A concern in multiple-tug towages relates to emergency procedures in the event of loss of a tug's power. If, for example, the lead tug in a three-tug spread blacks out, then it could be over-ridden by the FPSO, with catastrophic consequences. Suitable emergency procedures and tow equipment will be required to mitigate such a possibility.

21.5.6 Additional or larger tugs may be required if it is not possible or practical to provide an emergency anchor. See also Appendix F.

21.6 BALLAST, TRIM AND DIRECTIONAL STABILITY

21.6.1 Directional stability under tow may be compromised resulting in the FPSO veering off the course line. This is due to various factors related to the design and construction of the FPSO, including but not limited to;

a. The presence of a mooring or riser turret, below the keel of the vessel, generally at the forward end or midlength.

b. The removal of the vessel's rudder, where the FPSO is a conversion

c. The hull design of purpose-built FPSOs

d. High windage structure at the fore end.

21.6.2 The lack of directional stability can be hazardous due to;

a. Lack of sea room in congested and/or confined waters, e.g. Dover Strait

b. Accelerated deterioration of the towing gear caused by excessive movement.

21.6.3 To limit the loss of directional stability the hull must be carefully ballasted, trimmed by the stern and in the case of a ship-shape hull with the forefoot well immersed. This will also reduce slamming in heavy weather. The ballast distribution must be checked to ensure that the shear and longitudinal bending moment are within acceptable limits.

21.6.4 Consideration may also be given to attaching a towing vessel at the stern of the FPSO (see also Section 21.6.5).

21.6.5 Careful design of the towing gear may mitigate the problem. Consideration may be given to towing by the stern. If this is proposed then any motions analysis or model testing shall recognise this configuration. The strength of the hull in way of the stern shall be checked to ensure that;

a. The stern can withstand the anticipated slamming loads

b. Suitably sized towing connections and fairleads are or can be attached.

21.7 TOWING EQUIPMENT

21.7.1 Requirements for assisting tugs to provide additional manoeuvring control, and to assist with berthing or connection to the permanent mooring system shall be assessed for;

a. Departure

b. Any intermediate ports

c. Any shelter areas

d. Bunkering

e. Arrival.

21.7.2 The towing equipment shall be configured to accommodate additional and assisting tugs and to allow connection and disconnection when required. These activities may dictate the equipment on board the unit. For example, tugger winches, davits or cranes could be needed.

21.7.3 As noted in Section 21.6, FPSOs may exhibit a lack of directional stability during towage. There are two key tow-gear-related issues to address this problem and minimise the risk of gear failure;

a. The towing brackets on the vessel need to be wide-spaced, preferably more than one-half of the beam

b. The chafe chains should be generously oversized (typically +50%) to allow for accelerated wear during the voyage.

21.7.4 At least one emergency towline is mandatory, and means to recover each bridle after any breakage shall be provided. The possible manning of the vessel will influence the type and location of any recovery gear.

21.8 SELF-PROPELLED OR THRUSTER-ASSISTED VESSELS

21.8.1 In some cases, the FPSO may have its own propulsion, which may be either the original ship's system or thruster units to be used in service. If these are to be used for the voyage to site, the vessel must comply fully with all regulatory requirements.

21.8.2 The specification of the thruster units, power supplies and manning should be reviewed, to ensure that they are compatible with the voyage requirements.

21.8.3 A risk assessment shall be undertaken to determine the need for assisting tugs.

21.9 MANNING AND CERTIFICATION

21.9.1 Most FPSOs are not classed as ships during their service life. The documentation set out in Section 5 shall be provided.

21.9.2 If the towage is to be manned, then the requirements of Section 17 shall be considered.

21.9.3 Regardless of the presence of construction or commissioning personnel, a dedicated marine riding crew is recommended, as shown in Section 17.1.3.

21.9.4 In all cases, whether manned or unmanned, the unit must be fitted with appropriate means of boarding, in accordance with Section 13.14.

21.10 USE OF AN EMERGENCY ANCHOR

21.10.1 If practical, an emergency anchor shall be provided, as set out in Sections 16 and 20.6. An anchor may be required in an emergency situation, for instance in the event of a broken towline, or tug failure due to breakdown or fire.

21.10.2 FPSO mooring systems (whether turret-type or spread), being only for in-place conditions, are not configured to act as emergency moorings during transit. On a conversion the permanent anchors will often be removed. For many designs the deck space where an emergency anchor might be sited is taken up with the permanent mooring equipment.

21.10.3 For FPSOs, an emergency anchor may be impractical, and alternative means of achieving an equivalent level of safety shall be demonstrated.

21.10.4 Arguments for and against the provision of anchors are set out in Appendix E, with guidelines on attainment of an equivalent level of safety.

21.11 MOORINGS

21.11.1 The need for moorings before, during or immediately after the towage shall be considered. Design and layout of such quayside moorings should be incorporated into the overall arrangement of the vessel.

21.11.2 Wherever an FPSO hull is moored in shallow water, a minimum of 1m underkeel clearance must be maintained at all levels of tide for the duration of the vessel's stay in a particular location. The clearance should be calculated after consideration of;

a. Lowest predicted astronomical tide,
b. Maximum negative surge
c. Other environmental factors,
d. Weight growth due to construction activities and loading of modules,
e. Ballast, trim and heel changes,
f. Bottom protrusions,
g. Hull girder bending,
h. Water density,
i. Squat (when moored in a river or tidal stream),
j. Seabed conditions.

22 SPECIAL CONSIDERATIONS FOR THE TOWAGE OF VESSELS AND STRUCTURES IN ICE COVERED WATERS

22.1 GENERAL

22.1.1 This Section sets out the special technical and marine aspects and issues not covered elsewhere in these Guidelines, that will be considered by Noble Denton for the approval of the towage of ships, barges, MODU's and any other floating structure towed in ice-covered waters.

22.1.2 It is recognized that towing in ice-covered water is a unique marine operation and that all vessels and towages in ice are different - making these guidelines general in nature. Each approval will depend on the result of an in-depth review of the tow-plan as well as an equipment inspection/attendance by a surveyor to identify any particular problems that may exist for the specific vessel(s) and towage in question.

22.1.3 Structural safety and towing performance will require careful consideration of the size and shape of the vessel being towed, especially with respect to the beam of the towed vessel in comparison to the beam of the towing vessel and the shape of the bow of the towed unit. The beam difference will affect the level of ice protection provided by the tug to the tow, as well as the ice interaction and towing resistance caused when the beam of the tow is greater than that of the tug and/or of any independent icebreaker support. In addition, special towing techniques used in ice and manoeuvrability restrictions caused by the ice require that experienced personnel plan and execute the tow.

22.1.4 Except as allowed by Section 22.1.5, any vessel that is operated and/or towed in ice shall be in Class with a recognized Classification Society and have a current Load Line Certificate.

22.1.5 Special cases may be considered for the towage of vessels with a Load Line Exemption Certificate or for objects with no classification such as caissons and vessels with expired classification such as a demolition towage. In such special cases an inspection will be carried out and, in order to verify if the structural strength and watertight integrity of the tow is approvable for the intended voyage, the attending surveyor may require one or more of the following;

a. An extended, in depth, survey of the vessel structure involving one or more specialist surveyor(s). Facilities for a close-up survey of inaccessible parts of the hull structure may be required.

b. Thickness determination (gauging) of specified areas of the vessel structure. This survey may be in limited areas or extend over large parts of the hull structure. Such surveys shall be carried out by a reputable independent company. An existing survey report may be acceptable provided that it is not more than 1 year old, and there is no evidence of damage or significant deterioration since that date.

c. A Noble Denton review of classification society approved scantling drawings.

d. Calculations to show that the structural strength of particular local areas of the vessel is adequate. The extent of the calculation required to be determined by the results of the surveys and drawings review.

22.1.6 Should any doubt exist as to the ability of the vessel (object) to complete the proposed towage, after all the necessary surveys and calculations have been undertaken, a dry dock survey of the vessel may be necessary.

22.1.7 After complying with the requirements of Sections 22.1.2 to 22.1.4 listed above, Noble Denton may deem that the vessel/object is unfit for tow and decline to issue a Certificate of Approval. For example, the towage of any vessel or object which is damaged below the waterline, is suspected of being damaged below the waterline or has suffered other damage or deterioration which could affect the structural strength and/or watertight integrity will not be approved for towage in ice. Alternatively, the vessel/object may only be considered fit for tow after specified repairs and suitable ice strengthening has been carried out.

22.2 VESSEL ICE CLASSIFICATION

22.2.1 The tug(s) and towed vessel shall have an appropriate ice classification or equivalent for transit through the anticipated ice conditions identified in the Tow Plan and verified by Noble Denton.

22.2.2 Classification societies and regulators are in the process of harmonizing requirements for ice class. The anticipated result for ice breakers is that a new classification (eg.'Polar Class') will be created.

22.2.3 The following tables summarize nominal ice classification equivalencies for some classification societies and regulators.

22.2.4 It is important to note that the structural requirements of various classification societies are different and that many requirements have changed substantially over the years so that the 'equivalencies' shown in the tables should only be used for general guidance. This may result in a vessel's ice capability being interpreted by Noble Denton to be different to that indicated by the table.

22.2.5 Vessels classed as Ice breakers;

Polar Classes	Russian	LRS	Canadian Arctic Class CASPRR	DNV	Operating Criteria	
					Typical WMO ice type and thickness capability	Ice thickness
PC 5	(LL4) LU6	C1	CAC4	Ice 05	Winter ice with pressure ridges	0.5 m
PC 4				Ice 10	Thick first year ice with old ice inclusions	1.0 m
PC 3	(LL3) LU7	AC1.5	CAC3	Ice 15		1.5 m
				Polar 10	Multi-year ice floes and glacial ice inclusions	2.0 m
PC 2	(LL2) LU8	AC2	CAC2	Polar 20		
PC 1	(LL1) LU9	AC3	CAC1	Polar 30		3.0 m

22.2.6

22.2.7 Vessels classed For Ice Navigation;

Canada (ASPPR)	GL	Russian	ABS	BV	DNV	LRS	Typical WMO ice type and thickness capability
E	E	(L4) LU	D0	ID	Ice C	ID	Grey (0.0 m - 0.15 m)
D	E1	(L3) LU2	1C	1C	1C	1C (Ice 3)	Grey white (0.15 m - 0.3 m)
C	E2	(L2) LU3	1B	1B	1B	1B (Ice 2)	Thin first year (1st stage) (0.3 m - 0.5 m)
B	E3	(L1) LU4	1A	1A	1A	1A (Ice 1)	Thin first year (2nd stage) (0.5 m - 0.7 m)
A	E4	(UL/ULA) LU5	1AA	1A Super	1A*	1A Super	Medium first year (0.7 m - 1.2 m)

For Russian Classes L-ICE U-REINFORCED A-ARCTIC

22.3 TOWAGE WITHOUT INDEPENDENT ICEBREAKER ESCORT

22.3.1 Where no independent icebreaker escort is identified in the tow-plan for the intended voyage, the tug and tow must be of appropriate ice classification and power to maintain continuous headway in the anticipated ice conditions. When a tow is anticipated to take more than three (3) days (the maximum for a reasonably accurate weather/ice forecast) or longer in ice conditions that includes a concentration of five (5) tenths or more of limiting ice types, the tow-plan must indicate the location of the nearest icebreaker support and the anticipated time before independent icebreaker assistance (Coast Guard or Commercial) can be provided.

22.3.2 With the exception of a vessel pushed ahead (push-towed), the ice classification requirement for the towed object may be considered for reduction if it is determined that the tug has a higher than necessary level of ice classification and can protect the tow from potentially damaging ice interaction.

22.3.3 **Conventional tow operations;**

a. the tug must have sufficient power and hull strength (ice classification) to be capable of safely maintaining continuous towing headway through the worst anticipated ice conditions, including if necessary, the breaking of large diameter floes and deformed ice with no requirement for ramming and;

b. the tow-plan must show that the towage should not be subjected to ice pressure.

22.3.4 Close-couple towing operations;

22.3.4.1 Close-couple towing is an operation that allows a specially designed icebreaker to combine towing and icebreaking assistance. The stern of the icebreaker has a heavily fendered 'notch' into which the bow of a ship is pulled by the icebreaker's towline. The towline remains attached and the icebreaker steams ahead, usually with additional power provided by the towed vessel in the notch. In this way an icebreaker can tow a low-powered and low ice classed ship quickly (up to 3 times faster than conventional towing in ice) and safely (better protection of the towed vessel and less risk of collision due to over-running) through high concentrations of difficult ice. For close-couple towages;

a. The beam of the icebreaker must be more than that of the towed ship in order to avoid shoulder damage to the towed vessel and excessive towline stress and;

b. The icebreaker is fitted with a constant tension winch or equipment that will reduce the effects of shock-loading;

c. The bow of the towed ship must be compatible with the notch design of the icebreaker. Preferably the entrance of the towed ship is not so sharp as to apply excessive force on the stem when going straight ahead and freedom of movement of the towed ships bow causes maneuvering difficulties as well as applies heavy side forces on the towed ships bow when turning. The bow should not be so bluff so that all the force is concentrated in localized areas. In addition the towed ship cannot have a bulbous bow because the underwater protrusion could damage the icebreakers propellers and;

d. The displacement and freeboard of the towed vessel should not be so disproportionate with that of the icebreaker that the maneuvering characteristics of the icebreaker are seriously compromised;

e. The anticipated ice conditions should not require ramming or passage through areas where high levels of ice pressure may be experienced without independent icebreaker assistance.

22.3.5 Push-tow operations;

22.3.5.1 Push-Tow operations can be carried out using rigid connection (composite unit) or flexible connections (a push-knee erected at the stern of the pushed vessel). In some cases where the design and ice strength of the tug and tow is appropriate a tug may opt to push rather than tow in ice, especially when experiencing ice pressure, so that headway can be maintained and to remove the stress from the towline.

22.3.5.2 In some cases a push-tow is a more efficient and a more desirable method of ice transit to conventional towing, however, in all circumstances where the push-towing technique may be used, it is important that the pushed vessel has appropriate ice strengthening, particularly in the bow and shoulder areas.

22.3.5.3 The ice classification of a tug that is engaged in a 'push-tow' operation with no independent icebreaker support can be reduced if;

a. the vessel being pushed has appropriate ice classification and strength for unescorted transit in the anticipated ice conditions and;

b. the beam of the pushed vessel is greater than that of the tug. The beam of the pushed vessel should be at least one third greater than that of the tug to allow suitable manoeuvring for a flexible connection and;

c. the connection between tug and tow is of suitable strength for emergency stops and;

d. the tow-plan shows that the 'push-tow' will not enter, or be exposed to, an area where ice pressure may be encountered of sufficient severity to stop the continuous forward progress of the push-tow without independent icebreaker assistance.

22.4 TOWAGE OPERATIONS WITH INDEPENDENT ICEBREAKER ESCORT

22.4.1 The ice classification requirements indicated in Section 22.2.3 for the tug(s) and towed vessel(s) may be considered for reduction if it is determined that appropriate icebreaker escort assistance is provided for the duration of the tow in ice and that;

a. The icebreaker(s) has sufficient capability to allow the towage to maintain continuous headway through all of the anticipated ice conditions and,

b. The icebreaker(s) has a beam equal to, or greater than, the tug and tow combination or;

c. The icebreaker(s) is fitted with suitable and operational equipment such as azimuthing main propulsion units or compressed air systems that are capable of opening the track wider than the beam of the escorted towage in the anticipated ice conditions or;

d. More than one icebreaker will be used to provide a broken track equal to, or wider than, the beam of the tug and tow combination.

22.5 MULTIPLE TOWS AND MULTI-TUG TOWS

22.5.1 Multiple Towages in ice are subject to the appropriate provisions set out in this section regarding ice classification, equipment and suitable propulsion power as well as the general provisions (particularly those presented in Section 18). However, only in exceptional circumstances of very light ice and/or very low ice concentration (trace) should a Double Tow (Section 18.1.1) or a Parallel Tow (Section 18.1.3) be considered for approval. An in-depth risk assessment would be required

22.5.2 In addition to the provisions presented in Section 18 concerning towing operations that use more than one tug;

a. To avoid collision or over-running when more than one tug is towing a vessel or object as described in Sections 18.6 and 18.7, in ice each must be fitted with an operational towing winch brake quick release (tow-wire abort system) that can immediately release and pay out tow-wire and be re-applied (re-set) from the navigation bridge.

b. The most experienced tug Master, with typically not less than 3 years of in-ice towing experience in conditions similar to those anticipated for the proposed towage, shall be designated as the tow-master and give direction to the other vessels. All other tug Masters and senior navigating officers involved in the multi-tug towage should have an appropriate level of experience of towing in ice and be familiar with the associated difficulties and hazards.

c. A multi-tug tow-plan that is presented to Noble Denton for approval that does not include independent icebreaker escort assistance shall demonstrate clearly why it is not considered necessary. As an acceptable example, the tow could be configured such that one or more tugs with the capability to perform ice management (escort duties) can be released, and the remaining tug(s) have sufficient BP to continue making towing progress. In some circumstances a tow-plan can include the contingency of releasing one or more tugs that are towing in the conventional manner to push-tow provided that;

- the towed vessel is appropriately ice strengthened;
- the towed vessel is appropriately designed and strengthened in the pushing location(s);
- he tugs are designed and adequately fendered for pushing;
- such action would only be considered in a high ice concentration where there is no influence by sea or swell.

d. When two tugs are towing in series as described in Section 18.6 in an ice infested area, special attention shall be given to the strength of the towing connections on the foredeck of the second tug in case it is necessary for the lead tug to break through ice floes of varying thickness that may cause shock-loading.

e. A tandem tow of barges as described in Section 18.4.2 is sometimes referred to as ice-coupled. Where the presence of ice increases the potential for rapid changes to the towing speed, this type of close connection necessitates good fenders to be in place between each unit in the tow. In addition, the tug should be fitted with a tow winch brake release system that allows immediate tow-line pay-out to increase manoeuvrability in the event that the tug unexpectedly encounters thick ice and is in danger of being over-run.

22.6 TOWING EQUIPMENT

22.6.1 General

22.6.1.1 The towing techniques that are used in ice typically require a short distance between the tug and tow to increase manoeuvrability and so that the propeller wash from the towing vessel can assist in clearing ice accumulation around the bow of the towed vessel. Because of the short towing distance and reduction of towline catenary it is necessary for the towing arrangement to be suitable for the additional stress that can be experienced. The stress on the towing arrangement can vary considerably with;

a. the thickness and concentration of ice as well as ice pressure (conditions);

b. the difference in beam between the tug and tow resulting in ice interaction on the shoulders of the towed vessel and ice accumulation in front of the tow as well as the use and effectiveness of independent icebreaker escort (protection) and;

c. maneuvering through and around ice and unintentional tug interaction with heavy ice floes can result in large heading deviations of the tug and tow causing for example, shock-loading to towing components due to whiplash and the tow taking charge (hazards).

22.6.1.2 It is for these reasons that additional provisions concerning towing equipment strength, type and configuration are necessary.

22.6.2 Additional equipment requirements relevant for towing in ice

22.6.2.1 In addition to Section 12.5 (Tow-line Control), a tug involved in towing in ice infested waters must be fitted with an operational towline quick release/reset system (tow-wire abort system);

a. when towing in ice that could rapidly reduce towing speed or;

b. when a tug is involved in a multiple tow or;

c. when a tug is involved with a multi-tug tow.

22.6.2.2 The towline quick release system should be capable of immediate winch brake release for pay out of tow-wire as well as winch brake re-set from the navigation bridge.

22.6.2.3 With reference to Section 12.9, a tug involved in a towage in ice should be fitted with at least two searchlights that can be directed from the navigation bridge.

22.6.2.4 As recommended in Sections 12.11.2 and 13.16, every tug that is towing in ice shall be equipped with burning and welding gear for ice damage control and repair.

22.6.2.5 In addition to Section 12.13 concerning manning, special consideration should be given to the number, qualification and experience of personnel required on the navigating bridge to ensure safe navigation including steering and engine control, lookout, operation of searchlights, emergency operation of the towing winch abort system.

22.6.2.6 The master in charge of a tow (tow-master) should typically have at least 3 years experience of towing in ice conditions similar to those anticipated for the proposed towage. Other navigating officers on tugs involved in a towage in ice should also have previous experience of towages in ice.

22.6.3 Strength of Towline

22.6.3.1 With reference to Section 13.2.1 (a);

22.6.3.2 A tug that is planning a conventional single towline towage in ice the **minimum** towline breaking load (MBL) should be computed as follows;

Bollard Pull (BP)	MBL (tonnes)
BP ≤ 40 tonnes	3.7 x BP + 12
40 < BP ≤ 90 tonnes	(4.2 – BP/50) x BP + 24
BP > 90 tonnes	2 x BP + 60

22.6.3.3 An exception can be made for short tows in very thin 'new' ice or in very low concentrations (<3/10ths) of medium or thick 'rotten' ice. In these circumstances the **minimum** towline breaking load (MBL) should be computed as shown for a 'non-benign' tow in Section 13.2.

22.6.3.4 The strength of all other towing connections and associated equipment should be appropriately calculated as required by the provisions of Section 13.2.

22.6.3.5 Further, ALL tugs involved in a towage in ice must carry a spare tow-wire of the same length and strength as the main tow-wire that is immediately available to replace the main tow-wire. In addition, there must be enough equipment and spares on board to crop and re-socket the main tow-wire at least once.

22.6.4 *Special Cases of reduced tow-wire strength*

22.6.4.1 The minimum size of tow-wire that is typically used by icebreakers of 160te BP for close-couple towing is for example, 64mm EIPS rove through a multiple sheave floating 'Nicoliev Block' system. A single bridle wire is made fast on each bow of the vessel being towed that is usually of the same size and strength as the icebreaker's main tow-wire. This makes the bridle wire the 'weak link' in the system and because of this the icebreakers shall carry sufficient spare bridle wires, typically at least 6.

22.6.4.2 To meet the minimum towline strength criteria a tug that has an appropriate bollard pull may, in exceptional circumstances, be considered for approval of a conventional towage in calm waters containing ice using two towlines provided that;

a. Each of the two independent towlines is a minimum of 90% of the required strength and;

b. Each tow-wire is on a separate towing winch that can be adjusted, quick released and reset independently from the other and;

c. Each tow-wire meets the requirements of a single tow-wire in terms of minimum length, construction etc. and;

d. Each tow-line has a monitoring system to enable load sharing and;

e. A spare towline is carried on a reel and is immediately available to be put into service should one tow-wire fail when towing and;

f. The tug carries suitable spares and equipment to re-socket a broken towline.

22.6.5 Towing Winches

22.6.5.1 Due to the typical manoeuvring restrictions and hazards that are inherent to towing in ice, tugs should avoid towing from towing hooks or other arrangements that do not allow for the rapid adjustment of towline length.

22.6.5.2 The towing winch should have sufficient pull to allow the towline to be shortened under tension. When possible, the navigating bridge and winch operator should be provided with continuous readouts of towline length deployed and towline tension.

22.6.5.3 Winch controls and winch operating machinery should be suitably protected from environmental conditions, particularly low temperatures that can result in winch malfunction.

22.6.5.4 Towing winches should be fitted with an operational brake release system to allow rapid release of towline tension in an emergency and also a winch drum brake re-set that can be activated from the navigating bridge and the winch control station (if different).

22.6.6 Chain Bridles

22.6.6.1 Except where wire is sometimes used for small barge and vessel tows, especially when the close-couple or ice-couple towing technique is anticipated, a chain bridle is typically used for a towage in ice with a chain pigtail connected to a 'fuse wire' or directly to the towline. In some circumstances where high shock loads are anticipated, an extra long chain pigtail may be considered appropriate.

22.6.7 Synthetic Rope

22.6.7.1 Synthetic rope is prone to rapid cutting both internally by ice crystals and externally by ice edges and therefore is not approved for use in a towing system for an in-ice towage. Sections 13.8.2 and all parts of Section 13.9 do not apply in ice transits or in very low temperatures where icing can occur.

22.6.8 Bridle Recovery System

22.6.8.1 In addition to the requirements of Section 13.10;

a To reduce direct ice interaction and disconnection of the bridle recovery wire, the wire should be lightly secured to one leg of the bridle and the end shackled onto the apex or a chain link close to the apex of the tri-plate.

b The fuel mentioned in Section 13.10.2 for a motorized recovery winch shall be appropriate for the anticipated temperatures.

22.6.9 Emergency Towing Gear

22.6.9.1 With reference to Section 13.11, special arrangements may be required for the emergency towing gear, especially on an unmanned tow proceeding in ice. For all towages in ice the emergency towing gear should be fitted and arranged to tow from the bow unless it can be shown that the object being towed is designed for multi-directional towing.

22.6.9.2 A floating line and pick-up buoy are susceptible to being cut and lost or snagged by ice and pulled clear of the soft lashings or metal clips. It is recommended that a different arrangement is employed in high concentrations of ice. For example, an intermediate wire may be attached to the end of the emergency tow-wire and lightly secured to a pole extended astern at least 5 metres. The eye of the intermediate wire is suspended above the surface of the ice approximately 1 metre above the aft working deck of the tug where it can be captured for connection to a tugger-winch wire. The float line and pick-up buoy are shackled to the emergency tow-wire in the same way as described in Section 13.11.2, but remain coiled on the deck of the tow for deployment once the towage arrives in open water.

22.6.10 Access to Tows

22.6.10.1 With reference to Section 13.14, whether a tow is manned or not, suitable access must be provided. For towages in ice, the one permanent steel ladder described in Section 13.14.1 should be provided at the stern from the main deck to just above the waterline. As discussed in Section 13.14.2, ladders, particularly side ladders should be recessed to avoid ice damage. A tug workboat should carry suitable equipment to de-ice access recessed arrangements and ladders to tows. Pilot ladders used as a short term alternative should be closely inspected for ice damage before being used. Typically, a pilot ladder secured at the stern of the tow is subject to the least amount of ice interaction.

22.6.11 Towing Equipment Certification and Special Precautions

22.6.11.1 As described in Section 13.12, all equipment used in the main and emergency towing arrangements for a towage in ice shall have valid certificates. Special precautions are necessary for equipment that has been, or will be, used in extremely low temperatures. Regardless of anticipated temperatures during the proposed towage, a Noble Denton surveyor may request to have sockets, chains, flounder plates and shackles used in the towing process non-destructively tested (NDT). Based on the results of a visual inspection of the tow-wire, the surveyor may also require that the tow-wire is cropped and re-socketed prior to the towage.

22.6.12 Recommended Safety Equipment for the Workboat

22.6.12.1 In addition to Section 12.6, sufficient arctic survival suits shall be carried on board the tug for all personnel that may be operating the workboat and personnel transferred to the tow by the work boat. These additional survival suits should be fitted with hard soled boots, belts and detachable gloves.

22.7 TUG SUITABILITY

22.7.1 The tug shall have a bollard pull appropriate for the anticipated ice and weather conditions. The calculated BP should never be less than that necessary for an open ocean towage, as shown in Section 12.2.

22.7.2 Oversized Tug

22.7.2.1 For all towages in ice Section 13.2.9 concerning towing connections does not apply. In the case of an oversized tug (in terms of TPR) all connections should be at least equal to the MBL of the tow-wire in use. The tow-master must be fully aware of any strength reduction to the connections, carry adequate replacement spares and the towing procedures should identify the maximum power setting that may be applied.

22.8 CARGO LOADINGS

22.8.1 Special attention should be given to cargo overhangs on a case-by-case basis.

22.8.2 In general, cargo overhang for a towage in ice will not be approved unless it can be shown that the cargo is adequately protected such that no ice interaction can occur.

22.8.3 To determine the potential for ice interaction, calculations must show that the cargo has at least three meters clearing height above the maximum height of ice deformity that can be experienced during the tow. In all ice concentrations this minimum clearing height will be maintained in all conditions of roll, pitch and heave (reference Section 7 and 8). Due to the potential for ice impact and resulting damage cargo overhang cannot be allowed to immerse under any circumstance, so that Sections 7.6, 8.5, 10.1.4 and 10.1.5are not applicable.

22.9 SEA-FASTENING DESIGN AND STRENGTH

22.9.1 The motions of a vessel transiting through low concentrations of ice should be assumed to be as severe as those experienced in clear open water storm conditions. Swell waves can persist for many miles even into an ice edge of very high ice concentration. In high ice concentrations where no waves are evident, impact or over-running of thick ice floes can cause sudden deceleration, heading deflections, listing and rolling of the tow. For these reasons design and strength of cargo and sea-fastenings for transportation in ice conditions should be of appropriate design and not less than that required for unrestricted transportations in non-benign areas - see Sections 7 and 8.

22.9.2 Inspection of Welding and Seafastenings

22.9.2.1 With reference to Section 9.7, consideration of special welding procedures and techniques may be necessary for sea-fastenings installed in very cold temperatures.

22.9.3 Pipes and Tubulars

22.9.3.1 With reference to Section 9.6.4 - stress on pipes in a stack, and Section 9.6.10 - open ended pipes, special consideration should be given to pipes filling with ice due to freezing spray and/or wave action in low temperatures and the potential to overstress lower levels of pipe, seafastenings and deck structures. The effect on the vessel stability should also be considered.

22.10 STABILITY

22.10.1 The stability of vessels operating in very cold temperatures and in ice conditions shall be reviewed by Noble Denton with due consideration given to the special circumstances. For example, vessels, including tugs and tows making a transit where there is a potential for vessel icing shall be included in the review for approval.

22.10.2 The intact range of stability of a towed vessel (referenced in Section 10.1.1) shall never be less than 36 degrees, including inland and sheltered towages.

22.10.3 For transit in ice-infested waters, the statement in Section 10.1.4 of these guidelines shall be modified to read 'Cargo overhangs shall be such that no immersion is possible in the anticipated environmental conditions'.

22.10.4 Section 10.1.5 referencing buoyant cargo overhangs does not apply to transits in ice.

22.10.5 With reference to Section 10.2.1, towed objects shall have positive stability with any two compartments flooded or broached.

22.10.6 The damaged stability relaxations for towed objects referenced in Sections 10.2.4 and 10.2.5 do not apply in any area where ice interaction can occur. Reference should also be made to Section 10.2.7.

22.10.7 The integrity of all underwater compartments of a tug and compartments subject to down-flooding must be safeguarded from flooding by watertight doors and hatches that access such compartments. This is a critical requirement for an approval to conduct a towage in ice. All compartment accesses must be checked for watertight integrity and kept closed at all times throughout the towage.

22.10.8 The draughts mentioned in Section 10.4.4 are the minimum for open water operations. In an ice environment, additional consideration must be given to the location of any specially strengthened 'ice belt' and to the exposure of areas vulnerable to ice damage such as propulsion and steering equipment that may require specific and/or deeper overall ice transit draughts.

22.10.9 A vessel being towed or pushed (regardless of being self propelled) shall not be excessively trimmed. On manned tows the trim should be appropriate to provide watch personnel with as much forward visibility as possible for observation of approaching ice conditions and the movements of other vessels involved in the towage to reduce the potential for ice impact and/or collision damage.

22.11 BALLASTING

22.11.1 Ballasting of the forepeak (to above the waterline) of a tug and towed vessel is done to assist with ice impact load dispersal. This also provides protection against developing excessive trim by the head in the event that a forward compartment is breached by ice and flooded. In addition, the emptying of a ballasted forward compartment can assist with exposing damage for emergency repair or to raise the damaged area clear to avoid continued ice interaction and escalation of damage.

22.11.2 Special precautions should be taken to avoid structural damage caused by pressurizing compartments when ballasting and deballasting due to water freezing in tanks or inside tank vent pipes. This is in addition to the freezing of tank vents from coating with freezing spray in very low temperatures.

22.12 VOYAGE PLANNING

22.12.1 In addition to the requirements listed in Section 14, a written voyage plan or tow-plan should be submitted for review and comment by Noble Denton in advance of a proposed towage in an ice-infested region.

22.12.2 The plan should include;

a. A general description of the proposed voyage (manned/unmanned towage etc)
b. Tug and tow particulars including ice classifications and certification
c. Research documentation indicating the anticipated ice/weather conditions
d. Routing including shelter and holding locations
e. Navigation and communications equipment appropriate for the region
f. Summary of tow-master and senior officer experience
g. Arrangements for receiving weather and ice information and/or routing
h. Voyage speed and fuel calculations including any bunkering requirements and procedures to comply with National regulations
i. Contingency fuel, hydraulic & lubricating oils of suitable viscosity for the low ambient temperatures
j. Main and emergency towing arrangements and certification
k. Stability calculations and location of all cargoes, consumables, ballast and pollutants for the tug and tow
l. Sea-fastening (cargo securing) arrangements
m. Arrangements for assist tugs for docking etc and for ice management as required
n. Damage and pollution control equipment as applicable
o. Contingency procedures for ice damage, tug breakdown, fire, broken tow, man overboard and the nearest icebreaker assistance.

22.12.3 In addition to the list in Section 14.5.1, prior to departure the tow-master of an unmanned towage should be supplied with the appropriate drawings that indicate the basic structure, watertight compartments, ballast system, cargo securing arrangements on the tow, and manuals that provide the tug crew with operating procedures for emergency equipment such as ballast pumps (ref. Section 15), the emergency generator, the emergency anchor system and the tow bridle retrieval system.

22.12.4 Re-fueling the Tug

22.12.4.1 The tow-plan should indicate the calculated fuel usage during the tow for the required power in the anticipated ice conditions.

22.12.4.2 For the portion of the voyage that will be carried out in ice conditions, in addition to the times listed in Section 6.2.2 - the operational reference period, and Section 6.7 – calculation of voyage speed, the planned duration will include;

a. typical towing speeds of not more than 2 knots in ice covered areas as a conservative estimate where the actual towing distance is unlikely to be direct. A towing speed of 5 knots may be used where it can be shown that the tow will only encounter very thin new ice or alternatively very low concentrations (<3/10^{ths}) of thick rotting ice and;
b. waiting for appropriate ice conditions for departure, transit and arrival and;
c. up to 25% additional fuel (and other consumables) may be required (see Sections 6.2 and 12.12).

22.12.4.3 The tow-plan must indicate compliance with the International, National and Local regulations and guidelines concerning the carriage of oil cargoes, the allowable quantity and distribution of fuel oil or any other pollutant or dangerous cargo. In addition, where a tow-plan indicates the requirement to re-fuel the tug from the tow or from another vessel this will normally require special approval from a National authority and also require that the tug carries appropriate pollution containment and clean-up equipment. The re-fueling approval from the appropriate jurisdiction, as well as the re-fueling procedure and equipment, shall be provided in the tow-plan for review.

22.13 WEATHER/ICE RESTRICTED OPERATIONS

22.13.1 In addition to the requirements of Section 6.3, for a towage in an ice infested area, dependable ice forecasts must be available and the tug must have appropriate equipment on board to receive ice information including ice maps, bulletins, advisories and forecasts.

22.14 DAMAGE CONTROL AND EMERGENCY EQUIPMENT

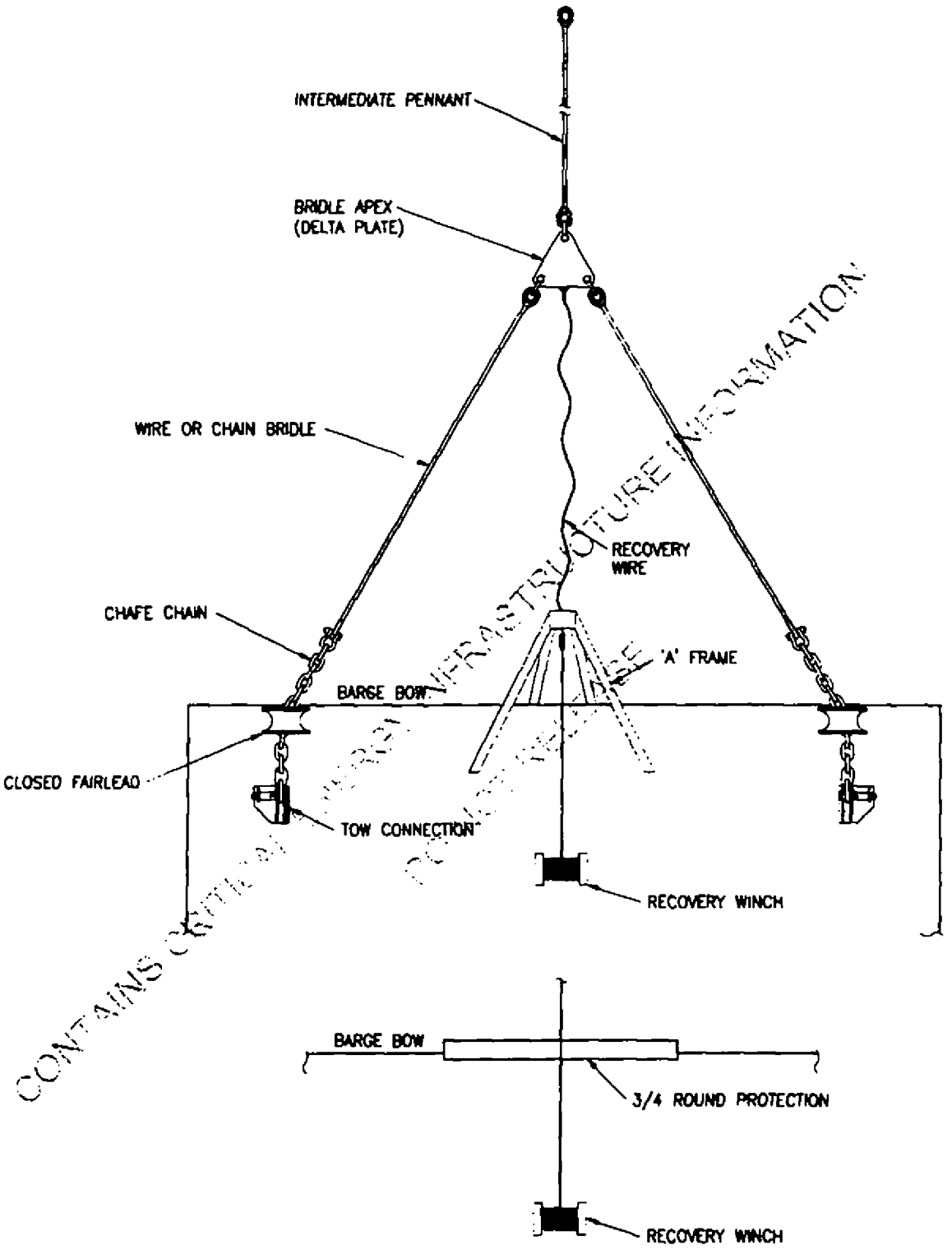
22.14.1 Special consideration should be given to the remoteness of the area and the anticipated ice conditions where a towage will take place to determine the availability of emergency response, assistance and equipment. In addition to the damage control equipment listed in Section 13.16, additional equipment is recommended for a towage in ice:

a. Portable generator
b. Portable compressor
c. Portable salvage pump(s)
d. Bracing shores
e. Portable de-icing equipment
f. Space heaters
g. Extension ladders
h. Chain falls
i. Collision mat materials.

REFERENCES

Ref no	Title
1	Noble Denton document 0009/NDI - Self-elevating platforms - guidelines for operations and towages *(to be revised, to delete references to towages)*
2	Noble Denton document 0013/NDI - Guidelines for loadouts
3	Noble Denton document 0015/NDI - Concrete offshore gravity structures - general guidelines for approval of construction, towage and installation
4	Noble Denton document 0016/NDI - Seabed and sub-seabed data required for approvals of Mobile Offshore Units (MOU)
5	Noble Denton document 0021/NDI - Guidelines for the approvability of towing vessels
6	0027/NDI - Guidelines for lifting operations by floating crane vessels
7	0028/NDI - Guidelines for the transportation and installation of steel jackets
8	IMO International Safety Management Code - ISM Code - and Revised Guidelines on Implementation of the ISM Code by Administrations - 2002 Edition
9	DNV Rules for the Classification of Ships, January 2003, Part 3, Chapter 1, Section 4
10	IMO Code of Safe Practice for Cargo Securing and Stowing - 2003 Edition
11	API Recommended Practice 2A-WSD (RP 2A-WSD), Twenty First Edition, December 2000, Errata and Supplement 1, December 2002.
12	API Recommended Practice 2A-LRFD (RP 2A-LRFD), First Edition, July 1, 1993
13	AISC Allowable Stress Design and Plastic Design, July 1, 1989, with Supplement 1
14	API RP 5LW - Recommended Practice for Transportation of Line Pipe on Barges and Marine Vessels
15	EEMUA 158 - Construction specification for fixed offshore structures in the North Sea,
16	AWS D1.1 - Structural welding code - steel
17	IMO Resolution A.749 (18) as amended by Resolution MSC.75(69) - Code on Intact Stability
18	International Convention on Load Lines, Consolidated Edition 2002
19	International Regulations for Preventing Collisions at Sea, 1972 (amended 1996) (COLREGS)
20	IMO MSC/Circ.623 - Piracy and armed robbery against ships - guidance to shipowners and ship operators, shipmasters and crews on preventing and suppressing acts of piracy and armed robbery against ships
21	IMO Document Ref. T1/3.02, MSC/Circ.884 - Guidelines for Safe Ocean Towing

APPENDIX A - EXAMPLE OF MAIN TOW BRIDLE WITH RECOVERY SYSTEM



OPTION FOR RECOVERY SYSTEM

APPENDIX A

MAIN TOW BRIDLE WITH RECOVERY SYSTEM

NOBLE DENTON
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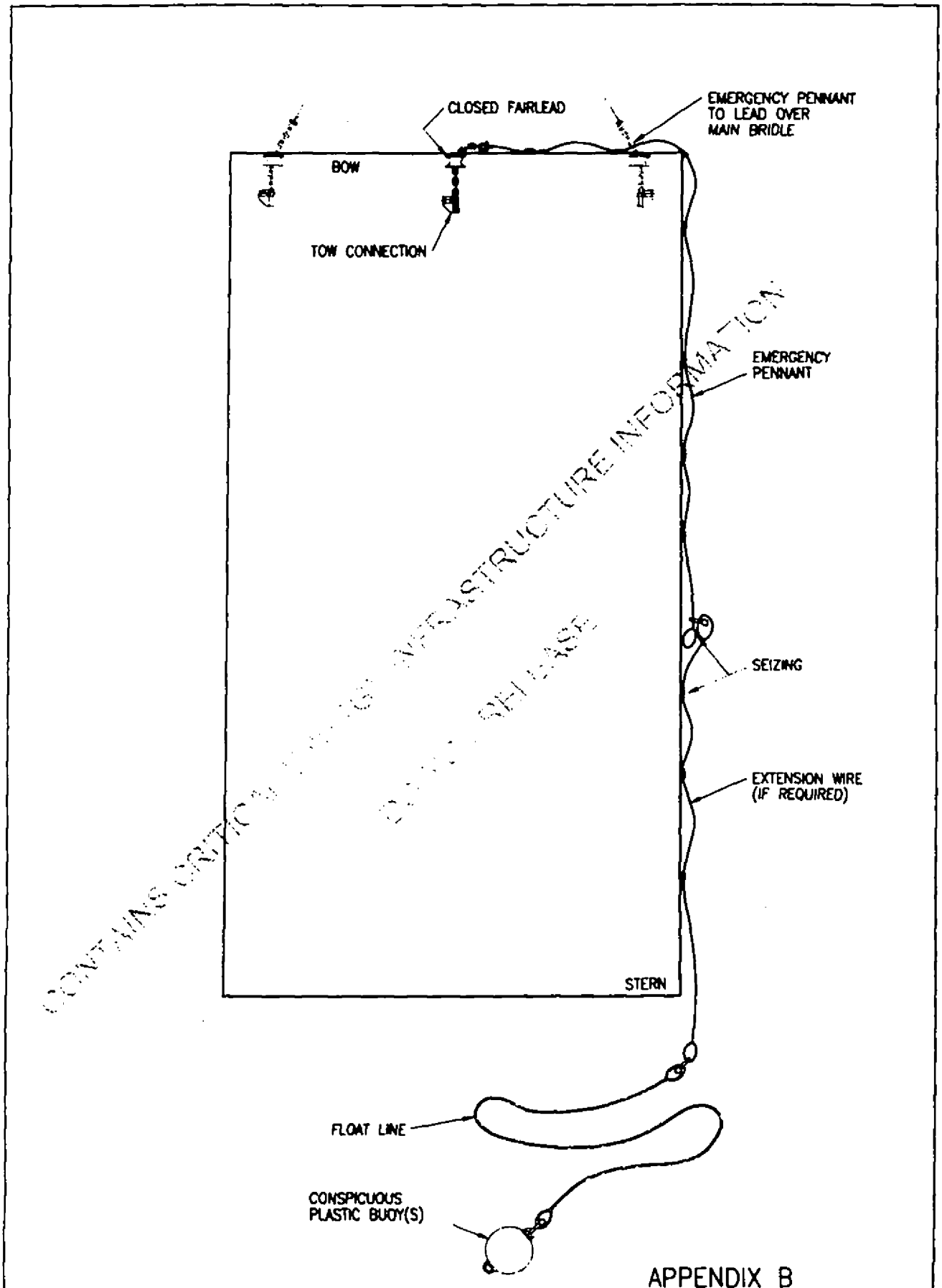
APPENDIX B - EXAMPLE OF EMERGENCY TOWING GEAR



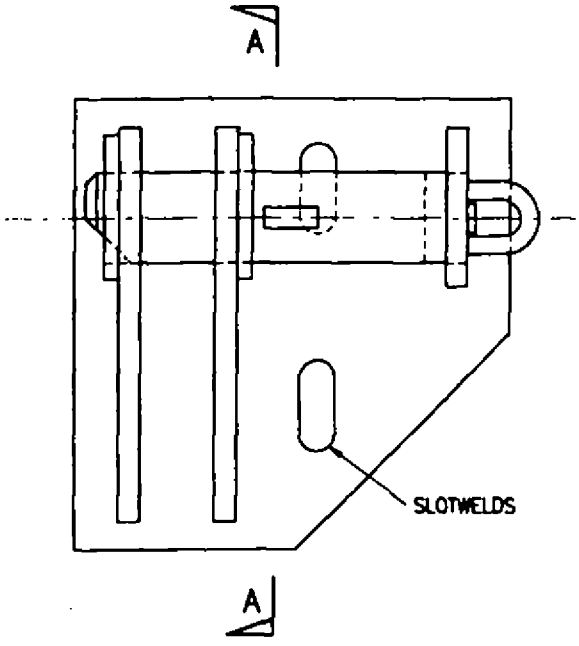
APPENDIX B

EMERGENCY TOWING GEAR

NOBLE DENTON

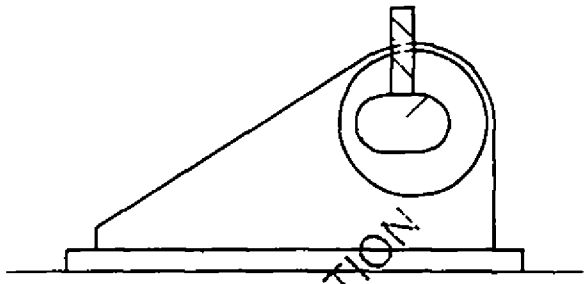
NOBLE DENTON INTERNATIONAL

APPENDIX C - EXAMPLE OF SMIT TYPE CLENCH PLATE

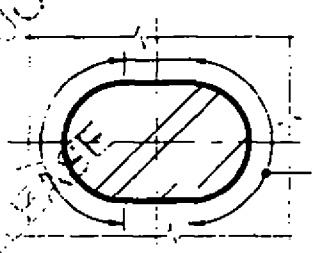


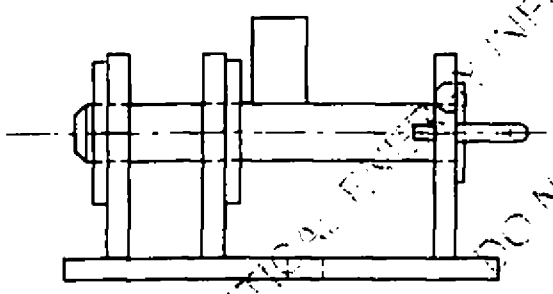
PLAN

STARBOARD CONNECTION AS DRAWN
PORT CONNECTION HANDED

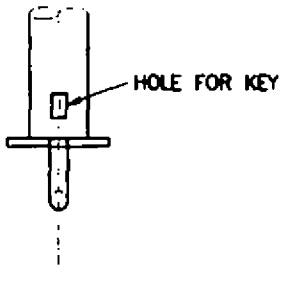


SECTION A-A

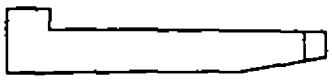


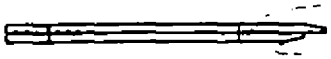


ELEVATION



PIN DETAIL





KEY DETAIL

NOTE:
DECK UNDERNEATH TO BE
REINFORCED AS NECESSARY.

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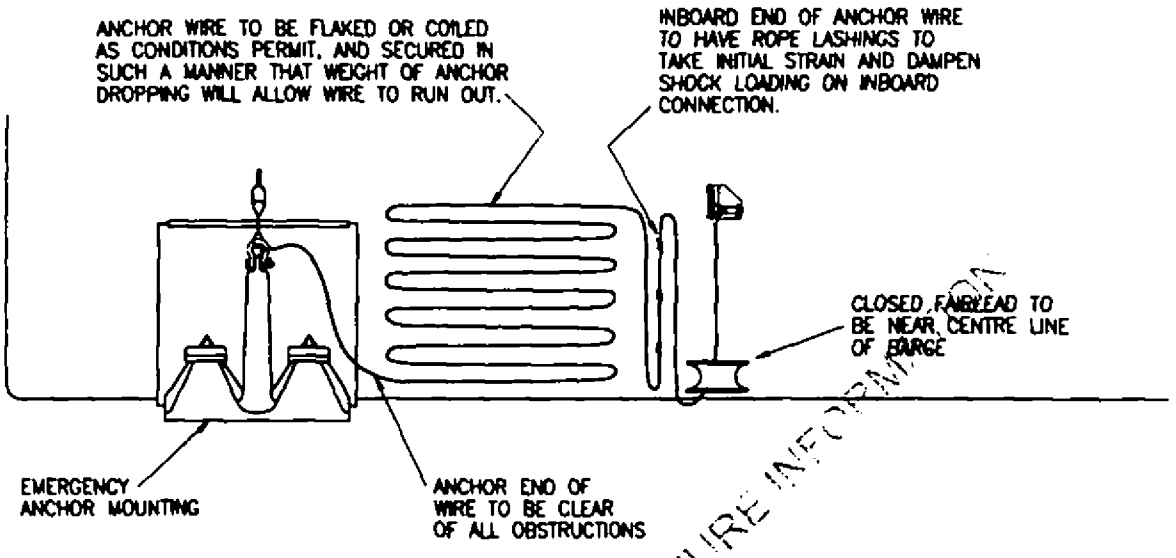
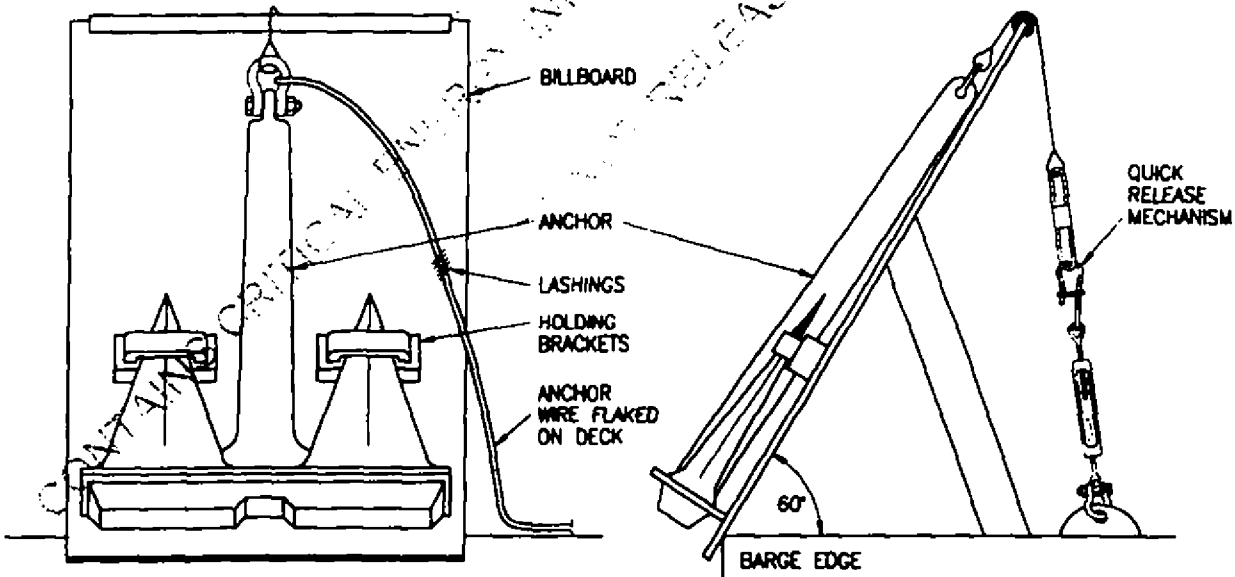
APPENDIX C
EXAMPLE OF SMIT TYPE
CLENCH PLATES

APPENDIX D - EXAMPLE OF EMERGENCY ANCHOR MOUNTING ON BILLBOARD



PLAN



FRONT VIEW

SIDE VIEW

APPENDIX D

EXAMPLE OF EMERGENCY
ANCHOR MOUNTING ON BILLBOARD

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APPENDIX E - ALTERNATIVES TO THE PROVISION AND USE OF AN EMERGENCY ANCHOR

E.1 Where practical, for any tow, an emergency anchor shall be provided, as set out in Sections 16 and 20.6. An anchor may be required in an emergency situation, for instance in the event of a broken towline, or tug failure due to breakdown or fire.

E.2 For very large tows, such as GBS's, TLP's and FPSO's, an emergency anchor may be impractical, and alternative means of achieving an equivalent level of safety should be sought.

E.3 FPSO mooring systems (whether turret-type or spread), being only for in-place conditions, are not configured to act as emergency moorings during transit. On a conversion the permanent gear is usually removed. For many designs the deck space where an emergency anchor might be sited is taken up with the permanent mooring equipment.

E.4 For any tow, there are arguments for and against the provision of anchors;

For;

a. Conventional marine and insurance industry practice is that an anchor is provided, and any alternative arrangement must be justified.

b. Once access is gained to the tow, or if the tow is manned, an anchor may provide a "last resort" method of controlling the tow.

Against;

a. A chain locker must be provided together with an anchor windlass, chain stoppers etc. and these will be for one use only. A billboard arrangement, as shown in Section 16.6 and Appendix D would almost certainly be ineffective for large tows.

b. Whereas ships, and ship-FPSO conversions may retain a hawse pipe, chain locker, anchor windlass, chain stoppers etc, most new build FPSO's are not fitted with these facilities.

c. For most of an ocean towage, and close to steep-to coastlines, the depth of water will be too great for an anchor to be effective.

d. If the tow is not manned, then boarding it in bad weather could pose an unacceptable hazard to the boarding crew, and deploying the anchor may prove to be impossible. In this respect a spare tug rather than an anchor would be more useful.

e. In some restricted areas anchoring is prohibited, even in emergency situations.

f. Unless the anchor can be paid out under control, the shock loads when the anchor beds in and the cable comes taut may be excessive, and could result in damage, loss of the anchor or unacceptable risk to the riding crew.

g. Under adverse conditions the anchor may drag, and the tow could still be lost

h. If 2 or more tugs are towing, then it is unlikely that any attempt to deploy an anchor would be made until all tugs or towlines had failed. If, for instance, 2 tugs were towing, dropping an anchor after a single towline failure would seriously hamper the efforts of the remaining tug to control the situation. An anchor will probably only be dropped, therefore, if all towlines break.

j. After deployment of an anchor the towage must resume at some point. The anchor must either be retrieved or cut and abandoned for later retrieval. It is probable that the tow would then be lacking an anchor, at least for a time. It is suggested that any anchor used is fitted with a retrieval pennant and buoy.

E.5 If sufficient towing capacity and redundancy is provided, in the towing spread, tugs will provide a more flexible and manoeuvrable means of controlling the tow. Reaction time will be faster and control should be possible in all water depths.

E.6 Proposed criteria, if anchor(s) are not used, include;

a. Provision of at least N main towing tugs, any (N-1) of which comply with the requirements of Section 12.2, or;

b. Provision of at least 2 main towing tugs, which together comply with the requirements of Section 12.2, and;

c. If 1 or 2 main towing tugs are provided, an additional tug will be required to escort the tow, if the tow comes within an agreed distance of any coastline or offshore hazard. (48 nautical miles is suggested, assuming the tow may drift uncontrollably at 2 knots for 24 hours).

d. The escort tug should be approximately equal in specification to the larger main towing tug

e. The escort tug is not required to hook up for escort duties, but contingency plans and equipment must allow for it to be connected rapidly, either in place of one of the other two tugs, or in addition, such that the configuration is still reasonably balanced.

f. In restricted waters, if one of the main towing tugs has a breakdown, it may be preferable to connect the escort tug to the bow of the broken-down tug, rather than to the tow

g. The towage route must be drawn-up showing the proximity to coastlines or other hazards, and the route sectors where an escort tug is required. Planning should ensure that the escort tug has time to arrive before the searoom is below the agreed limits.

E.7 A risk assessment must be carried out to justify the omission of anchoring facilities, and to satisfy all parties that the precautions proposed are adequate.